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REPORT OF ACTIVITIES
1979

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MINERAL INVENTORY

N. A. Lyttle

MINERAL OCCURRENCE MAPS AND CARDS

Metallic mineral occurrences have been compiled and plotted on the new geology base maps at a scale of 1:250,000, and the mineral occurrence lists to accompany these maps have been finalized and typed. The maps are presently being drafted and will be available on open file early in 1980. The Mineral Occurrence Data (MOD) cards that complement these maps have been updated with regards to remapped and renamed bedrock host units. It is anticipated that these cards will be typed in the near future. A metallic mineral occurrences edition of the new geology map, on a scale of 1:500,000, is in the final stages of preparation. Publication is expected early in 1980.

Industrial mineral occurrences have also been compiled and plotted on base maps at a scale of 1:250,000; the mineral occurrence lists have been finalized and typed; and the Mineral Occurrence Data (MOD) cards have been compiled for each occurrence. The maps are presently being drafted and will be available on open file early in 1980.

ASSESSMENT REPORT PROJECTS

(i) Index Maps to Assessment Reports

This series of index maps indicates the types of surveys and the regions of Nova Scotia that are described in company assessment reports held by NSDME. The maps are on a scale of 1:250,000 and are provided as eight sheets covering the following NTS areas: 11D; 11E; 11F, G and C; 11J, K and N; 20O and P; 21A; 21B; and 21H. For each NTS map area, four individual index maps are available indicating the following types of assessment report coverage: (i) geographic index to assessment reports (ii) geological map and survey index (iii) geochemical survey index (iv) geophysical survey index. The maps have all been drafted and will be available on open file early in 1980.

(ii) Microfilming of Assessment Reports

An additional 74 assessment reports have been microfilmed, covering the period September 1978 to February 1979. A list of these reports is available through the Technical Records libraries, and microfiche copies of these reports can be purchased from Precision Microfilming Services, 6061 Young Street, Halifax, N.S., B3K 2A3.

In addition, a majority of open file reports (approximately 340) have now been microfilmed. Microfiche copies of these reports can also be purchased from Precision Microfilming Services.

(iii) Geoscan Indexes to Assessment Reports

Further updating of the Geoscan (formerly the Canadian Index to Geoscience Data) indexes to NSDME documents has not taken place since

September, 1978. Consequently, a new supplement to Report 77-2 "Index to Mineral Assessment Reports", covering the period September 1978 to December 1979, has yet to be released. Indexing of assessment reports from this period has begun, and a new supplement will hopefully be available early in 1980. A list of open assessment reports, that are not included in Report 77-2 (and supplement), can be obtained through the Technical Records libraries.

NEW PROJECTS

(i) Index to Government Drillhole Records

An index, ordered by NTS, has been prepared for the annually published Drilling Logs of Government Core Drills, covering the period 1972 to 1978. This report is presently being typed and publication is expected early in 1980.

(ii) Assessment Reports Drillhole Compilation

Work has been initiated on compiling for publication all drillhole information contained in NSDME assessment reports. This information is being recorded on standardized drill record sheets, and drillhole locations are plotted on accompanying sections of NSDME Claim Sheet maps at a scale of 2 inches to 1 mile. To date, approximately 800 reports containing drillhole information have been identified, and of these, approximately 250 reports have been processed and recorded. Early publication of this information is not anticipated.

AGGREGATE RESOURCES OF EASTERN CAPE BRETON ISLAND

W. J. Wright and J. H. Fowler

INTRODUCTION

The inventory mapping program of sand and gravel deposits in Nova Scotia was completed in 1978. This program produced a series of open file maps which located and classified deposits of sand and gravel throughout the Province. As a result of this survey certain areas have been identified as having high aggregate demands while limited reserves were indicated.

In 1979 the eastern section of Cape Breton Island was selected for detailed aggregate resource evaluation based on the results of the inventory program and requests for additional information from aggregate producers and data users.

Project Area

The project area is bound by Latitudes 45°45', 46°30'N, Longitudes 59°45', 60°45'W and includes all or portions of topographic sheets 11F15, 11F16, 11G13, 11J4, 11K1, 11K2, 11K7, and 11K8. Field investigations in 1979 were restricted to sand and gravel deposit areas located on sheets 11J4, 11K1, 11K2, 11K7 and 11K8 (Figure 1).

Purpose of the Survey

The purpose of the survey is to identify all granular and bedrock aggregate resources within a 50 km radius of Sydney. In order to have optimum aggregate resource management, information as to the location, quality and quantity of extractable materials must be available. It is the intention of this survey to accurately map, sample, assay and calculate reserves of granular aggregate deposits and identify bedrock sites suitable for aggregate quarry operation.

Sources of Information

Research of existing surficial information was completed. This included examination of reports, theses, maps, data obtained from aggregate producers, and mineral exploration companies' assessment files.

A considerable amount of information was obtained from a series of large scale unpublished surficial maps and personal communication with the hydrogeological staff, Water Resource Planning Section, Water Planning and Management Division, Nova Scotia Department of Environment in Sydney.

A diamond drilling program by NSDME to evaluate coal reserves in Cape Breton has provided this survey with subsurface data in one of the deposit areas.

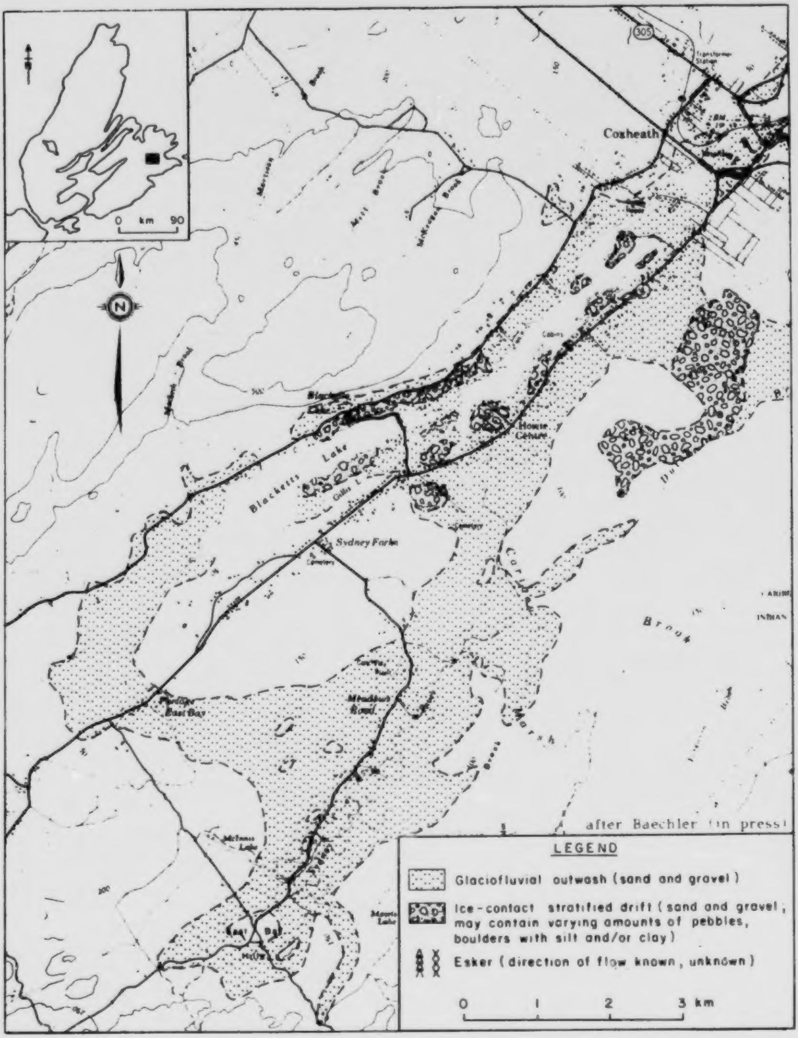

0 km 90
N
Coxheath
305
Blacketts Lake
Howie Centre
Sydney Forks
Meadow Road
East Bay
Brook
Marsh
after Baechler (in press)
LEGEND
Glaciofluvial outwash (sand and gravel)
Ice-contact stratified drift (sand and gravel; may contain varying amounts of pebbles, boulders with silt and/or clay)
Esker (direction of flow known, unknown)
0 1 2 3 km

Figure 1. Sand and gravel resources in the Sydney Forks-Meadow Road area.

After compiling all information from the various sources, an airphoto interpretation to locate landforms and drainage areas, believed to contain sand and gravel, was completed on topographic sheets 11J4, 11K1, 11K2, 11K7 and 11K8.

PRELIMINARY RESULTS OF THE SURVEY

Although few new deposits of sand and gravel were found, many known deposits have been remapped and are now substantially larger than previously indicated. Two important deposits are the Meadows Road deposit and the Mira River-Broughton-Homeville deposit. Both provide significant volumes of granular aggregate materials used in the Sydney area.

Meadows Road Deposit

A large deposit of sand and gravel occurs along the Sydney River from East Bay Hills northeast through Meadows Road and Howie Centre to Sydney River (Figure 1). From Meadows Road, a western and then northeastern extension of the deposit rims Blacketts Lake. A break in the deposit occurs at Blacketts Lake then a complex of outwash, kames and esker sand and gravel is continuous along the north side of Sydney River to Coxheath. Along highway #4, from Sydney Forks to Sydney River and along the north side of Sydney River from Blacketts Lake to Coxheath, residental development restricts sand and gravel extraction.

Large volumes of high quality aggregate are extractable in the Meadows Road area from East Bay Hills to the junction of Caribou Marsh Brook and Sydney River. Subsurface investigations next year may show a southward extension of the deposit in the East Bay Hills area.

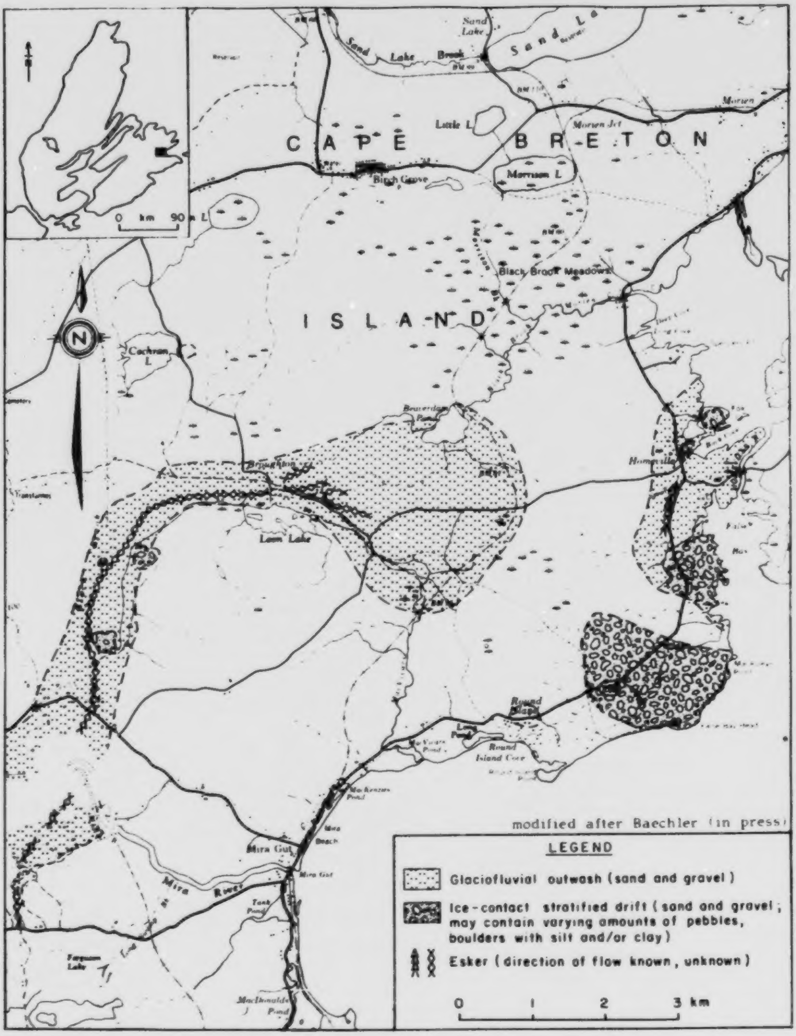
Mira River - Broughton - Homeville Deposit

Sand and gravel deposits occur along the Mira River from Huntington northeast along the river to where it begins its bedrock outlet to Mira Gut.

Increased residential and recreational land use limits sand and gravel extraction.

Of interest is the position of the Mira River channel previous to its cutting through its present outlet. Grant (1972, p. 161) stated "Mira River probably had an outlet via Broughton to Cow Bay (Morien Bay) before being dammed by drift and forced to cut a bedrock channel to Mira Bay". Recent mapping has shown outwash, kame and esker deposits of sand gravel extending north from the west end of the bedrock channel of the Mira River then east through Broughton toward Homeville (Figure 2). To the east, outwash and ice-contact stratified drift occur at Homeville. Subsurface investigations are required to determine if the Broughton deposit and the Homeville deposit are connected.

Subsurface data from boreholes drilled by the Coal Inventory Mapping Program, NSDME, indicate substantial thicknesses of sand and gravel in the Broughton area.



modified after Baechler (in press)

Figure 2. Sand and gravel resources in the Broughton-Homeville area.

Although aggregate specification tests have not been done on samples from this area, examination of pebble lithologies from surface exposures indicate a higher per cent of "soft" rock types as compared to the Meadows Road deposit.

Other deposits

Additional sand and gravel deposits have been mapped on the west side of Great Bras D'Or between Beinn Scalpie and New Campbellton and along the St. Anns Bay-Gulf of St. Lawrence shore between River Bennet and French River.

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A STUDY OF A SUCCESSION OF TILLS EXPOSED IN A WAVE CUT DRUMLIN, MEISNERS REEF, LUNENBURG COUNTY

R. Stea

INTRODUCTION

W. H. Prest (1896) described a complex sequence of till and recessional sediments exposed during trenching of bodies of drift he termed 'morraines' in the Mahone Bay area. He noted a lower 'dark coloured boulder clay' that contained basalt clasts of a northerly provenance underlying a locally derived, slate clast, auriferous drift. Later workers (Goldthwait, 1924; Wilson, 1938); recognized the 'morraines' of Prest as drumlins. They assumed that the drumlins were of uniform composition, namely till, derived from local slate bedrock of the Meguma Group (Wilson, 1938, p. 44). The hypothesis required that drumlins formed only in areas underlain by slate bedrock where clayey material was supplied by a 'plastering on and rubbing away process' (Goldthwait, 1924, p. 91).

MacNeill (1960a) noted the occurrence of distinctive till sheets exposed in some Mahone Bay drumlins and suggested that they recorded evidence of two to three glacial advances. Grant (1963) working in southeastern Nova Scotia noted that drumlins could be composed of a layer cake of as many as three lithologically and texturally contrasting till types. The common case is a grey, very compact, oligomictic, silt till, overlain in sharp contact with a reddish-brown, polymictic clay till. He suggested that the lower till was deposited during a separate glacial advance than the upper till, and that the contact represented an erosional interval during interstadial conditions. Grant (1975) named the upper till in the Halifax region, Lawrencetown till. Nielsen (1976) postulated that the lower grey till was a lodgement phase of the same advance that emplaced the Lawrencetown till. He suggested that changes in ice dynamics (e.g. shearing and erosion) could account for the erosional type contact. Both Grant (1963) and Nielsen (1976) inferred that the drumlins formed by accretion of the Lawrencetown till over the core of grey till. Goldthwait (1924) suggested that drumlin formation may involve something of both erosion and deposition, seemingly opposed processes.

The drumlin examined in this study, at Meisners Reef, reveals three till units, the upper one being reddish-brown and polymictic. This unit is believed to be correlative with the Lawrencetown till in Halifax County. With a nearby striated rock outcrop providing a unique control, the author will attempt to use till fabric analyses to correlate till units with specific directions of ice movement noted regionally. The till fabric method will provide a test of the hypotheses that:

1. Lawrencetown till was deposited during the ice movement that molded the drumlins.

2. The till units represent more than a single ice advance.

LOCAL DIRECTIONAL DATA

Stossed outcrops of slate and siltstone of the Halifax Formation (Cambro-Ordovician) occur a few hundred metres east along the beach from the drumlin sea cliff examined in this report (Figure 1). A pervasive set of glacial striations and grooves are inscribed on the stoss side of these outcrops, trending 140° and recording a flow to the southeast.

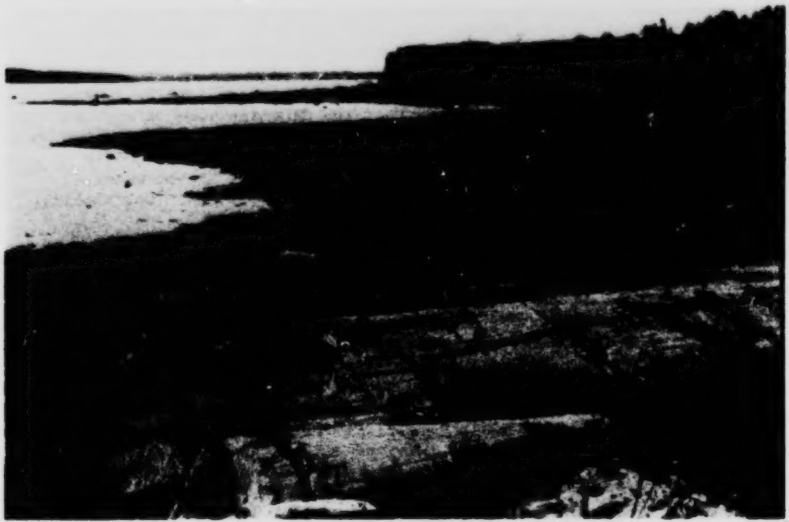

Figure 1. Stossed and striated bedrock surface (siltstone) near the drumlin section.

These are also associated with minor 150° trending striations. A set of faint striations oriented northeast-southwest crosscut the southeasterly trending striations. Preserved only on the lee slopes of some of the outcrops is another set of east-west (270°) trending striations. Therefore, these are probably the oldest set. There is a suggestion of lee side development facing west on some of the outcrops, thus indicating that the ice flow that produced these striations may have been to the west.

The drumlin examined in this study is oriented 150° (Figure 2). Orientation of drumlin axes in the area vary from 130°-150° with the suggestion of reorientation or deflection in some of the forms resulting from changing directions of ice flow. The stoss ends of most of the drumlins face northwest providing further evidence of ice flow toward the southeast.

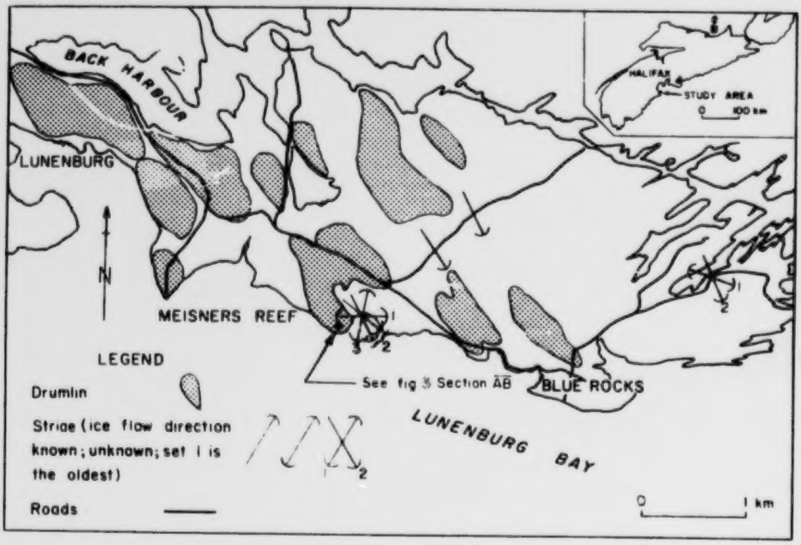

Figure 2. Map showing the distribution of drumlins and striations in the Lunenburg area.

STRATIGRAPHY OF THE DRUMLIN SECTION

The drumlin at Meisners Reef (Figure 2) is truncated by wave erosion nearly perpendicular to its long axis. A near vertical section is exposed with the sequence of tills displayed in Table 1 and Figure 3.

The lowest till (unit I) comprises the bulk or core of the drumlin while the upper two units mantle the form. Till unit II is found only in the centre of the drumlin where it is in slightly gradational contact with the core till (unit I). Till unit III mantles the whole drumlin and increases in thickness toward the drumlin flanks, where it rests directly on the core till (unit I) in sharp contact (Figure 4). In this area, the reddish-brown till (unit III) infills joint fissures in the lower grey till and produces wedges in the lower till. The joint traces of the lower grey till (unit I) are truncated at the upper reddish till contact (Figure 5).

Table 1. Sequence of tills exposed at Meisners Reef.

TOP

UNIT	THICKNESS	DESCRIPTION	LITHOLOGY (Average in each unit of 25 stone counts made at each fabric site).
III	1-3 m	TILL: reddish brown (10 yr 4/4), sandy matrix, noncalcareous, moderately compact, weathered, (some Fe-Mn oxide staining), elongate sand inclusions and partings parallel to plane of deposition.	basalt 50% granite 6% slate-metagreywacke 33% water-worked, well rounded pebbles 1%
II	2 m	TILL: greyish brown (5 yr 3/4), noncalcareous, thin sandy partings separating plates of till (fissility).	basalt 8.4% slate-metagreywacke 67% water-worked pebbles 6.7%
I	10-15?m	TILL: dusky yellowish brown (10 yr 2/2), silty matrix, calcareous, extremely compact, massive structure, jointing.	basalt 6.0% granite 16.9% slate-metagreywacke 64.0% water-worked pebbles 12.4%

METHODS

Two suites of fabric determinations were done using sample areas 50 cm X 50 cm on the vertical face of the drumlin. The bearings of 50 stones were measured. Only stones with long/short axes ratios of, 3:2 or greater were measured. These stones were restricted to prolate, tabular and rhombohedroid shapes defined by Holmes (1941) as the best indicators of glacial movement. Two areas were selected in the same till unit, at approximately the same depth, to measure between site variability as advised by Andrews (1971). The measurements were all taken from the central part of the drumlin to minimize the possible effects of contour deflection (Savage, 1968).

RESULTS

The results of the measurements are shown in Figure 3 as rose diagrams. Most stations in the lower core till (unit I) exhibit strong fabric maxima with dual peaks at the 130°-140° and the 150°-160° class intervals (Figure 3). The 150°-160° class interval becomes prominent at the top of the unit. Stations 1D, 1E and 2D also demonstrate strong 270°-280° trending peaks.

Till unit II exhibits peaks at 140°-130° and 190°-200° (Stations 2B, 1B). Station 1A in the upper reddish brown till (unit III) demonstrates peaks of 190°-200° and 240°-250°.

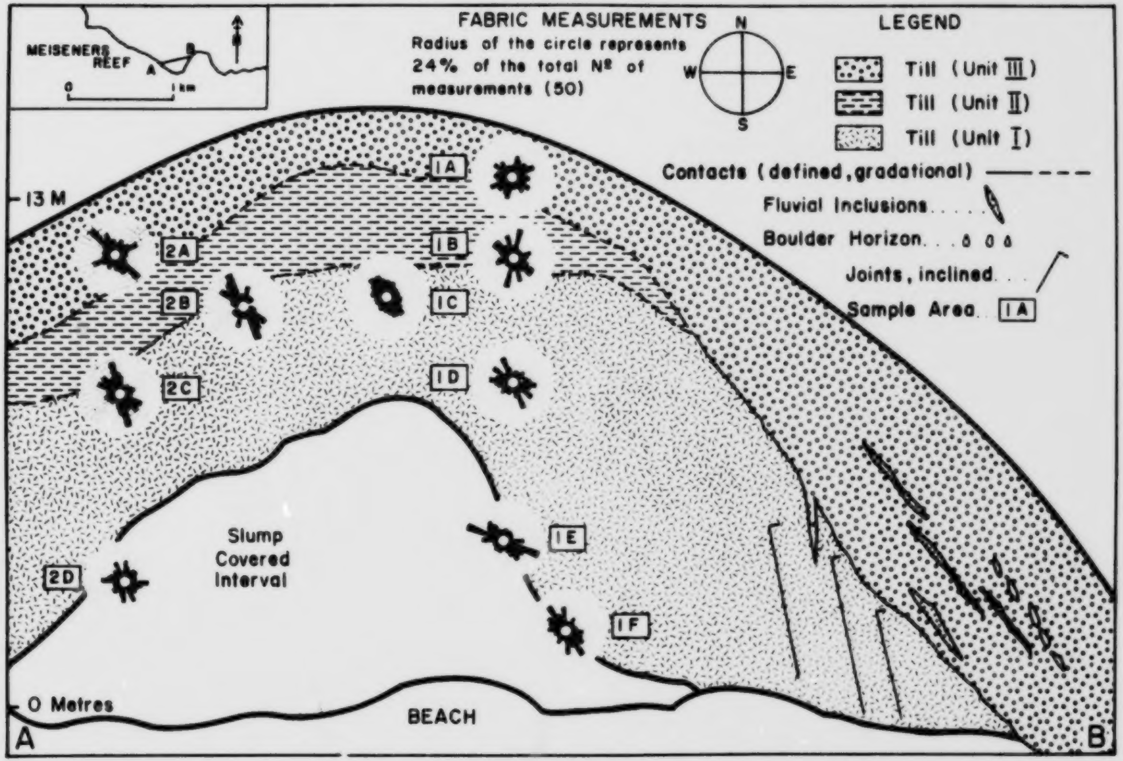

Figure 3. Schematic cross-section of the Meiseners Reef drumlin.

Figure 4. The contact zone of till units I and III on the flank of the drumlin. A wedge of till unit III intrudes till unit I.

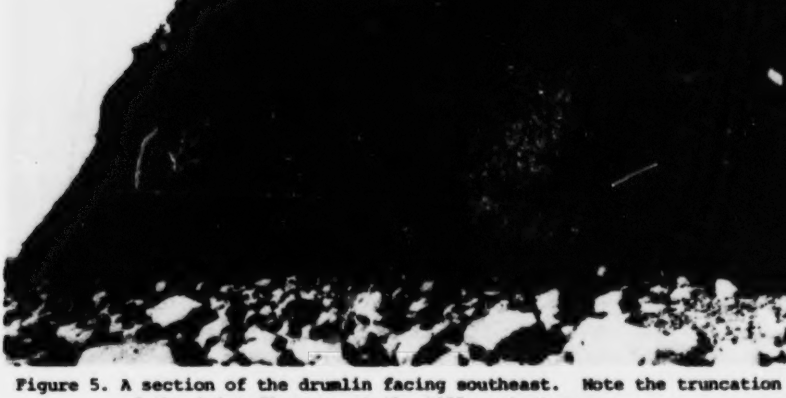

Figure 5. A section of the drumlin facing southeast. Note the truncation of the joint fissures at the till contact zone.

The lower core till (unit I) generally shows good between site agreement and records strong southeast-northwest aligned fabric with a component of east-west oriented fabric towards the base of the section. Till unit II again records the northwest-southeast fabric with elements of a northeast-southwest fabric, superimposed. Fabric in the uppermost till (unit III) seem more randomly oriented than the lower tills and exhibit northeast-southwest trending maxima. Station 1A shows a strong 140°-130° orientation in addition to the northeast-southwest trend, but that sample area was located across the gradational contact of till units III and II.

DISCUSSION

Given that:

1. The local major striation directions and drumlin axes correspond with most of the fabric maxima of the lower core till (unit I).

2. The core till (unit I) contains basalt fragments (derived presumably from North Mountain basalt outcropping to the north and northeast); and the assumption that the fabric elements were formed during the deposition of the till, one is tempted to conclude that the lower core till was emplaced during the regional southeastward ice movement that produced the drumlins.

How does one explain the east-west trending maxima evident in the lower stations? These may be in part due to the orientations of the rolling population of more rod shaped stones (Andrews and King, 1968; Holmes, 1941), however, these are usually 90° out of phase with the major mode. The concurrence of the east-west trending striations and some of the fabric elements is cause for further thought. It may be possible that southeastward flowing ice reworked most of the lower till fabric elements to conform to the direction of overriding ice.

Maclintock and Dreimanis (1964) presented evidence for fabric reorientation to a depth of 10 m. The paradox therefore becomes evident; is the fabric a primary depositional feature related to structural elements of the ice itself as Harrison (1957) and Wright (1957) suggested or secondarily produced through stress imposed by overriding ice (Gravenor and Menely, 1958; Evenson, 1971).

The author has observed a drumlin section at Broad Cove in Lunenburg County (Figure 6) revealing two till units separated in places by a bouldery, iron-cemented diamict. The lower till is similar to the core till at Meisners Reef, while the upper till resembles till unit II. The diamict contains boulders of granite and slate in a sandy matrix with intercalated sandy lenses. It is interpreted as an ablation till. If the two lower till units are correlative it would indicate further evidence that the lower core till (unit I) was predeposited before the drumlin forming advance, and later reworked in the drumlin form. The calcareous nature of the lower till and high granitic clast percentage also suggests provenance from the Mahone Bay area to the northeast and east of the drumlin site where Windsor Group limestones and Devonian granite outcrop, rather than from the northwest over predominantly Meguma terrane.

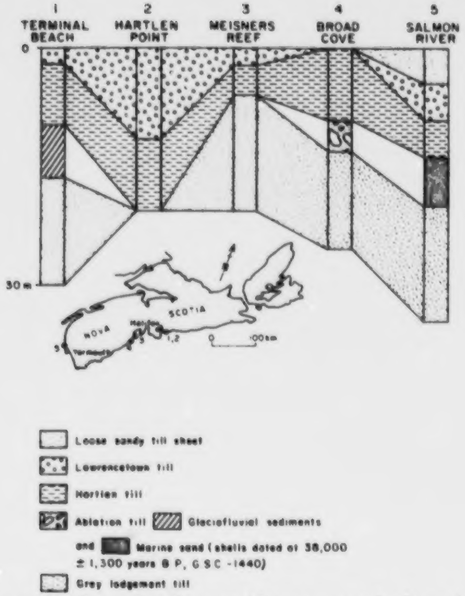

Figure 6. A correlation of major sections exposed along the Atlantic coast of Nova Scotia; the Terminal Beach and Hartlen Point sections are taken from Stea and Fowler, 1979; the Salmon River section is taken from Neilsen, 1976.

Fabrics in till units II and III, the mantling tills, change from southeastward trending maxima in the lower till (unit II) to southwest-northeast in the upper till (unit III). The author suggests that till unit II is a lodgement till partially reworked from the core till, deposited during the drumlin forming advance. It demonstrates strong preferred southeast pebble orientation, fissility, and a high percentage of locally derived clasts. This till does not occur throughout the drumlin section indicating that it may have been partly eroded prior to the deposition of the upper till (unit III).

The physical properties of the uppermost till (unit III): moderate compactness, longitudinal sand inclusions and weakly oriented clast fabric, indicate deposition by a melt-out process instead of active lodgement. If one assumes that a drumlin was formed by molding under active ice, then the role of the uppermost till in the drumlin formation was minimal. It may have been draped on the preexisting form. There is evidence, however, for a divergent late flow of ice occurring after the flow that molded the drumlin forms. Striations trending 190° crosscut the earlier 140° trending set conforming with the drumlin axes and the lower till unit's fabric maxima. The upper till (unit III) intrudes the lower core till (unit I) as a wedge shaped body at the drumlin flank. The wedge dips about 45° to the northeast (Figure 4).

Dreimanis (1969) and Mörner (1972) have suggested that till wedges (sensu stricto) dip down glacier and they form by a cracking and filling process. This would therefore imply an ice movement onshore to the northeast just previous to, or contemporaneous with, deposition of the uppermost till (unit III). One could argue that the joint cracks that these clastic wedges were infilling were opened up by frost action during a minor ice free period previous to the ice advance that formed the drumlin, and till (unit III) squeezed in when the basal melting occurred. The ablation till at Broad Cove, and stratified sediments, underneath 'dark coloured boulder clay' of a northern origin (Prest, 1896, p. 160), testify to a period of melting intervening between ice advances producing till units I and II.

CORRELATIONS

Nielsen (1976) named the lower core till in the Lunenburg drumlin field indurated till. He correlated this till unit with the lowermost till exposed at Salmon River in Yarmouth County, inferred to be early Wisconsinan in age (Grant, 1975). The lower mantle till (unit II) is correlative with Nielsen's (1976, p. 57) grey slaty till believed contemporaneous with the formation of the drumlins. He correlated this till unit with the grey lodgement till at Hartlen Point in Halifax County, informally termed Hartlen till by Stea and Fowler (1979). The upper till (unit III), as previously mentioned, is correlative with Lawrencetown till described by Grant (1963, 1975) in the Halifax area. The correlations are summarized in Figure 6.

CONCLUSIONS

From the evidence presented the author would conclude that Lawrencetown till was not deposited during the drumlin forming flow, but either draped on the lower drumlin forming lodgement till (Hartlen till) after stagnation of the southeastward flowing ice sheet directly, or after a minor flow reversal from an offshore ice centre. It is also suggested that the core tills (unit I) are remnants of an early Wisconsinan till sheet, reworked during the regional southeast ice flow that produced the drumlins in the "Classical Wisconsinan".

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OFFSHORE EXPLORATION FOR COAL IN THE SYDNEY COALFIELD - 1979

W. Potter and S. Forgeron*

In July, 1979 the Nova Scotia Department of Mines and Energy and the Cape Breton Development Corporation initiated a third offshore coal drilling program in the Sydney coalfield. The 1979 program was directed primarily towards the exploration of the Harbour seam along the western and southern boundaries of the Donkin Block and the Hub seam at Point Aconi (Figure 1).

The drilling program started on August 27th, using the "Ocean Tempest" a shipshape drilling rig owned and operated by Odeco from New Orleans, Louisiana. Four holes, P1, 2, 3 and 4, were drilled at Donkin and two at Point Aconi, P5, and 6 completing the 1979 program. Total cost of the program was $4 million.

RESULTS

Donkin

The Donkin Block contains a large in situ coal resource estimated at 1.898 billion tonnes. This resource is distributed among five coal seams: the Point Aconi, Lloyd Cove, Hub, Harbour and Phalen. If a conservative recovery factor of 35% is used then 664 million tonnes of coal may be ultimately recovered from the Block. Table 1 indicates the total in situ coal resources in a proposed mining block at Donkin and also indicates the various calculated recovery tonnages on the Harbour seam using selected mining criteria as indicated on the table. This clearly illustrates the increased quality of the coal if the inferior roof and pavement sections do not have to be mined. It should be further noted that the numbers in Table 1 are estimates only and do not necessarily reflect either the final recoverable tonnage or the ultimate quality.

Point Aconi

At Point Aconi, where the remaining two holes were completed, the drilling substantiated original projections for seam thickness and quality. An exception was hole P-6 (Figure 1) drilled near the centre of the mining block where the sulphur content (5.19%) was found to be higher than average (3%). This anomaly is attributed to the presence of a sandstone paleoriver channel which overlies the seam in that area. An initial recoverable resource of 75 million tonnes has been calculated for the Hub seam in the Point Aconi area.

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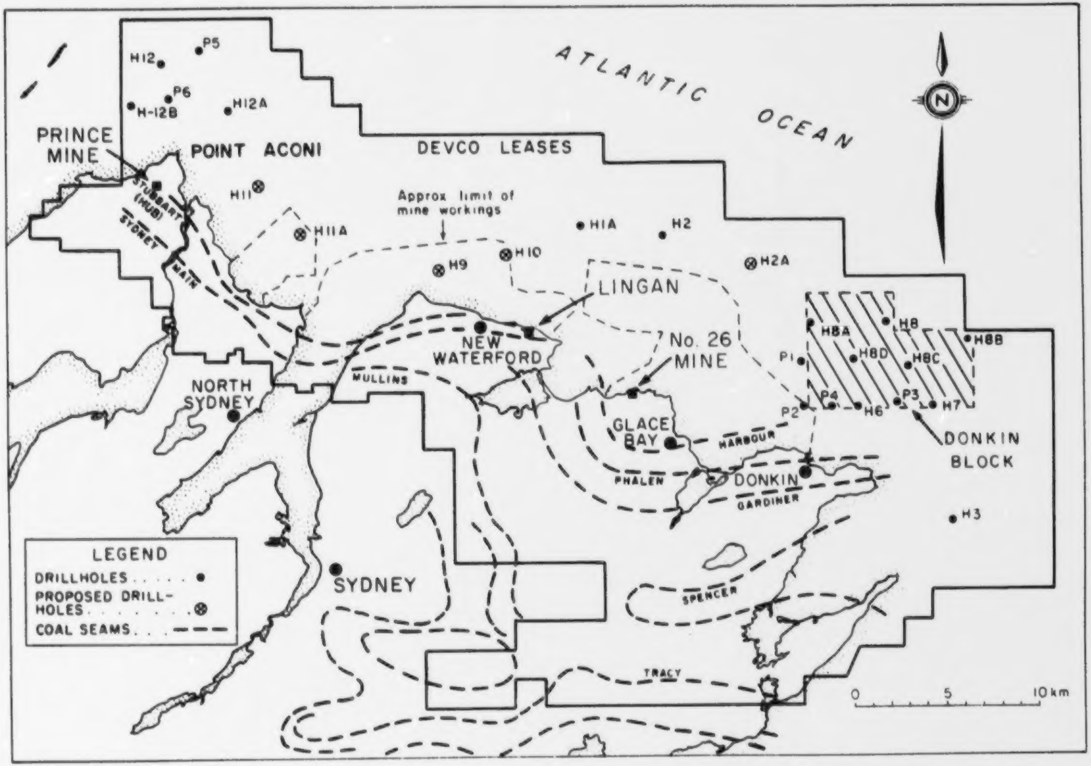
* Cape Breton Development Corporation, Glace Bay, Nova Scotia



1979

Figure 1. Location of boreholes for Coal Inventory, offshore Sydney, 1977-1979.

Table 1

Coal resources Donkin coal Block
(coal resources x 10^3 tonnes)

SEAM	DEMONSTRATED	INFERRED	% SULPHUR	% ASH	AVERAGE THICKNESS (m)	TOTAL RESOURCES
Pt. Aconi	-	94,000	4.44	6.91	1.86	94,000
Lloyd Cove	335,000	172,000	3.90	10.80	2.93	507,000
Hub	339,000	169,000	5.20	14.20	3.05	508,000
Harbour	441,000	228,000	4.07	9.70	2.96	669,000
Phalen	77,000	43,000			1.71	120,000
TOTALS	1,191,000	706,000				1,898,000

A. HARBOUR SEAM IN SITU RESOURCES -	669,000	@	4.07% sulphur,	9.70% ash
B. HARBOUR SEAM IN SITU DEMONSTRATED RESOURCES -	441,000	@	4.07% sulphur,	9.70% ash
C. RECOVERABLE RESOURCES (50% RECOVERY)	221,000	@	4.07% sulphur,	9.70% ash
D. POTENTIAL MINING AREA -	192,000	@	3.72% sulphur,	9.70% ash
1. Recoverable Coal (Total Seam) -	96,000	@	3.72% sulphur,	9.70% ash
2. Recoverable Coal (Leaving Inferior Roof Coal) -	89,000	@	3.47% sulphur,	8.46% ash
3. Recoverable Coal (Leaving Inferior Roof and Bench Coal) -	78,000	@	2.80% sulphur,	5.48% ash

SYDNEY COALFIELD

K. S. Gillis

GENERAL

The assessment of the potential surface resources in the Sydney coalfield during the 1979 field season was a continuation of the exploration program which began in 1978.

The Sydney coalfield was initially divided into five districts (Figure 1) and of these, three districts, the Port Morien, Glace Bay and New Waterford were assessed in 1978 (Gillis, 1979). The Sydney Mines district has received the most recent attention. The fifth district, Point Aconi, was assessed by a consultant in 1978.

In addition to the exploration in the Sydney Mines district, evaluation of the 1978 field work indicated that the Spencer and Tracy seams in the Port Morien district and the Gardiner seam in the Glace Bay district hold a potential surface resource and further evaluation of these seams was conducted during the 1979 field season. Additional work included detailed drilling for seam thickness and quality and more definitive locations of sample pits for coal quality testing.

LOCATION AND GEOLOGY

The Sydney coalfield is situated in northeastern Cape Breton Island, stretching along the coast for 48 km from Cape Dauphin southeast to Mira. It is composed of a land area of 500 km^2 and a submarine basin that is considered to occupy some 360 ha (Hacquebard, 1979).

The coal-bearing rocks belong to the Morien Group of Pennsylvanian age and based on megaflora and spore florule have been assigned a Westphalian C and D age (Hacquebard, 1979).

The Morien Group is divided into four biostratigraphic zones; three are found onshore and one is found in the offshore coal measures (Hacquebard, 1979). All zones consist essentially of arkosic grit, grey sandstones and shales with minor red beds and coal seams.

Thirteen coal seams are found in the field, ranging in thickness from 0.9 m to 4.3 m. All seams, except the three youngest, have been mined to some extent in the past.

The Sydney coals are classed as high volatile "A" bituminous coal.

SITE INVESTIGATIONS

Sydney Mines District

An exploratory drill program was carried out in the Sydney Mines district to outline possible sites for surface mining (Figure 2).

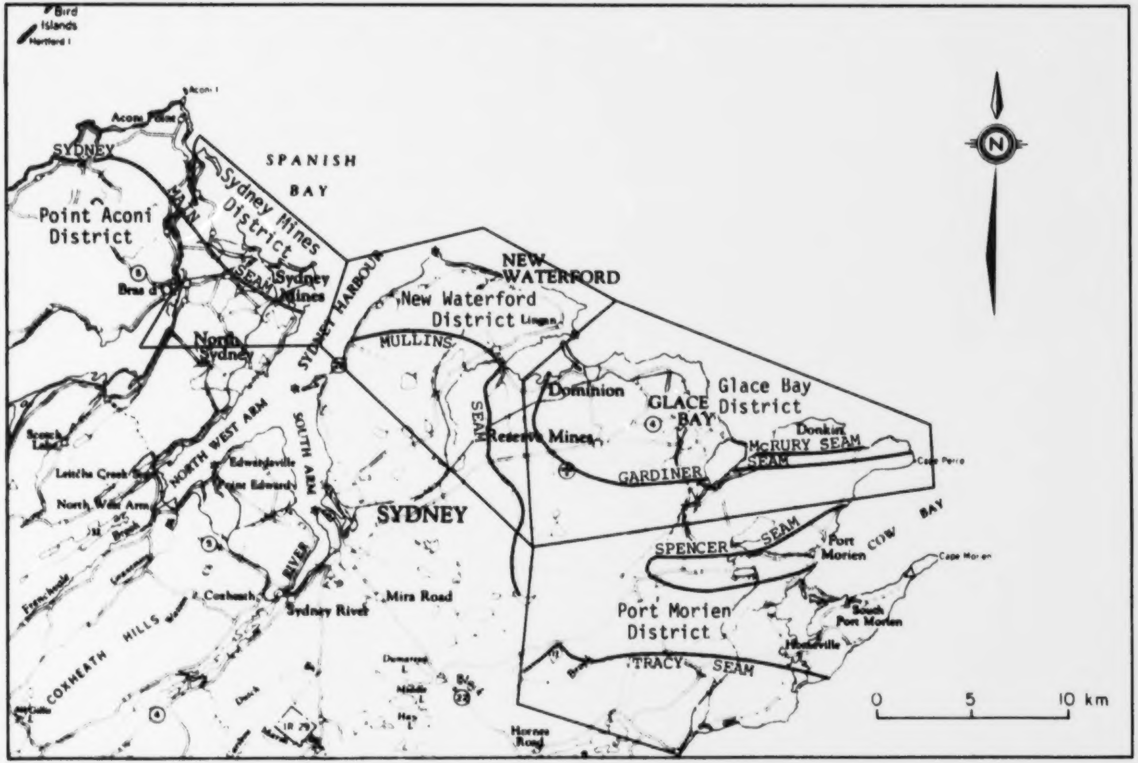


Figure 1. Districts investigated in the Sydney coalfield, 1978, 1979.

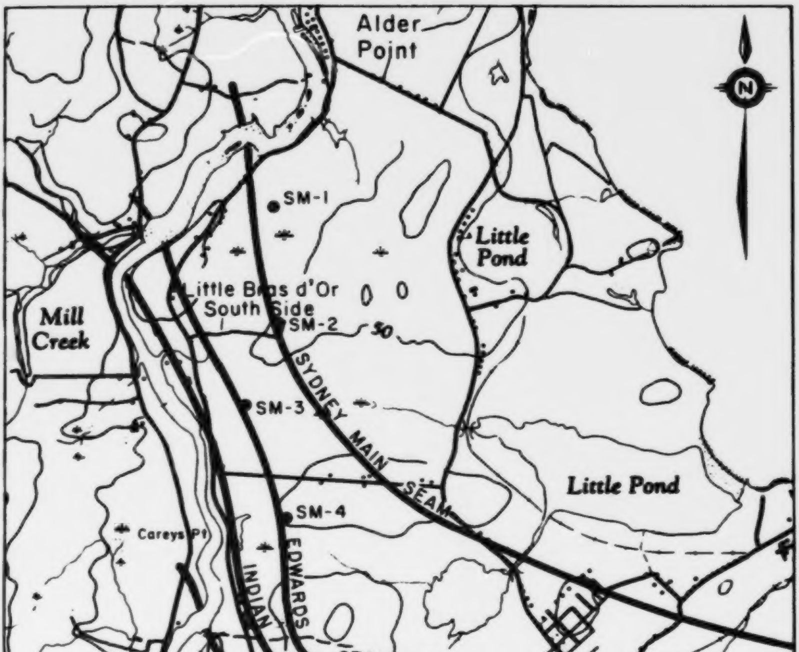


Figure 2. Location of drillholes and coal seams, Sydney Mines district.

Four seams were investigated and nine holes were drilled for a combined total of 226.6 m. An assessment of the drilling results has indicated three sites for potential surface coal; one site is found on each of the following seams: Sydney Main, Indian Cove and Collins. The three sites have a combined strike length of 1981 m and an average dip of 6°. For tonnages for the three sites combined at various strip ratios see Table 1.

Table 1

Sydney Mines district

Strip Ratios	10:1	12.5:1	15:1	20:1
Tonnages of in situ coal (metric tonnes)	668,440	835,490	1,002,957	1,337,018

Glace Bay District

In the Glace Bay district (Figure 3) three holes (GB-13, -14, -15) were drilled to more accurately define a 2000 m section on the Gardiner seam that had been drilled in 1978. This section lies north of the Sydney airport and contains 687,704 metric tonnes of in situ coal with an average ash and sulphur content of 14.00% and 2.70% respectively. The section lies updip between the old Dominion Number 25 Mine workings and the seam outcrop and so is limited in depth to 15 m.

Port Morien District

Spencer Seam

An additional twelve holes were put down on the Spencer seam (Figure 4) to further define an open-pit site that had been delineated from last years drilling, for test pit locations and for detailed drilling. Results of drilling have confined the area of influence to a 3350 m section south of Morrison Lake. For tonnages at the various strip ratios see Table 2.

Table 2

Port Morien district

Strip Ratios	10:1	12.5:1	15:1	20:1
Tonnages of in situ coal (metric tonnes)	493,467	619,300	740,199	991,044

A test pit (SP-A) was excavated on the seam and a 227 kg sample was sent for analyses. Average analyses for ash and sulphur yield 8.14% and 3.41% respectively with a calorific value of 13,380 Btu/lb.

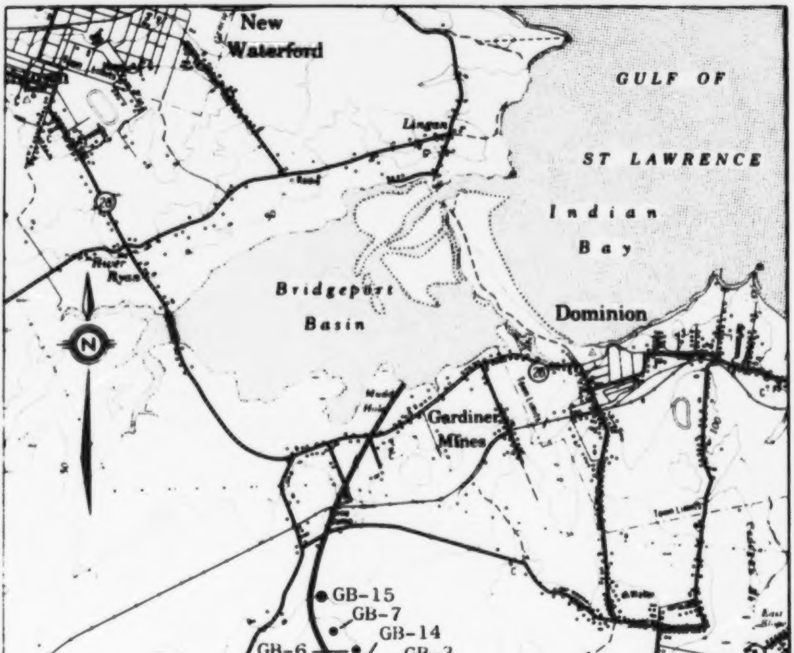


Figure 3. Location of drillholes and coal seams, Glace Bay district.

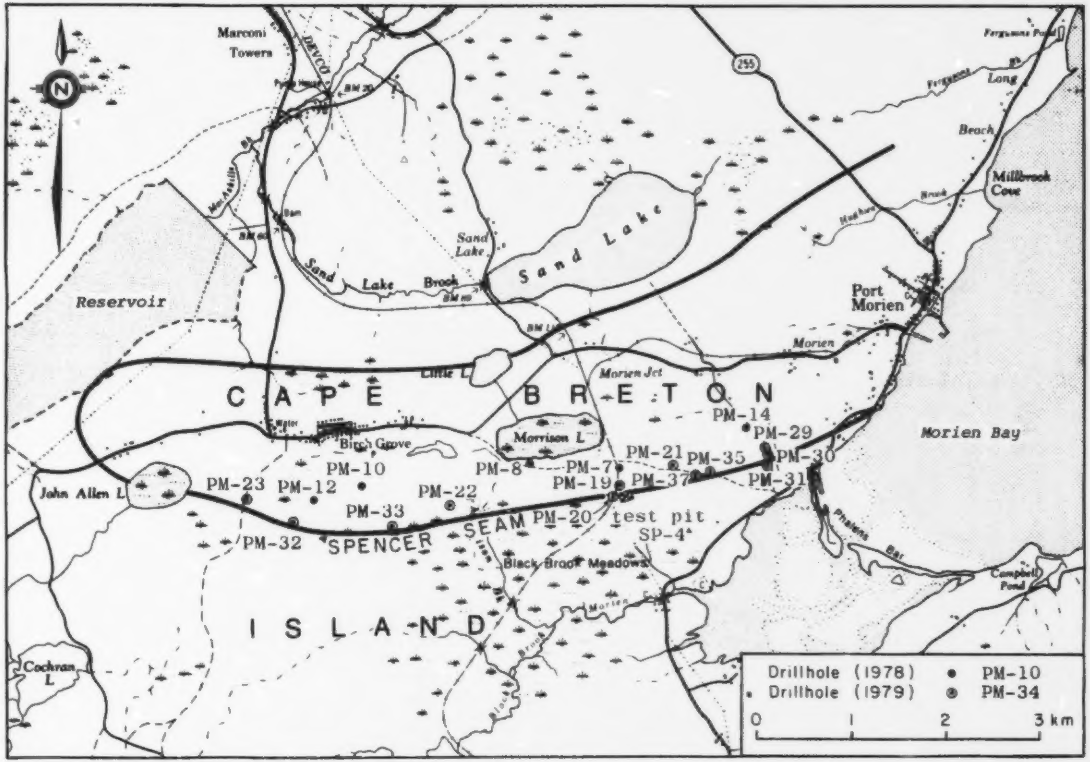


Figure 4. Location of drillholes on Spencer scam, Port Morien district.

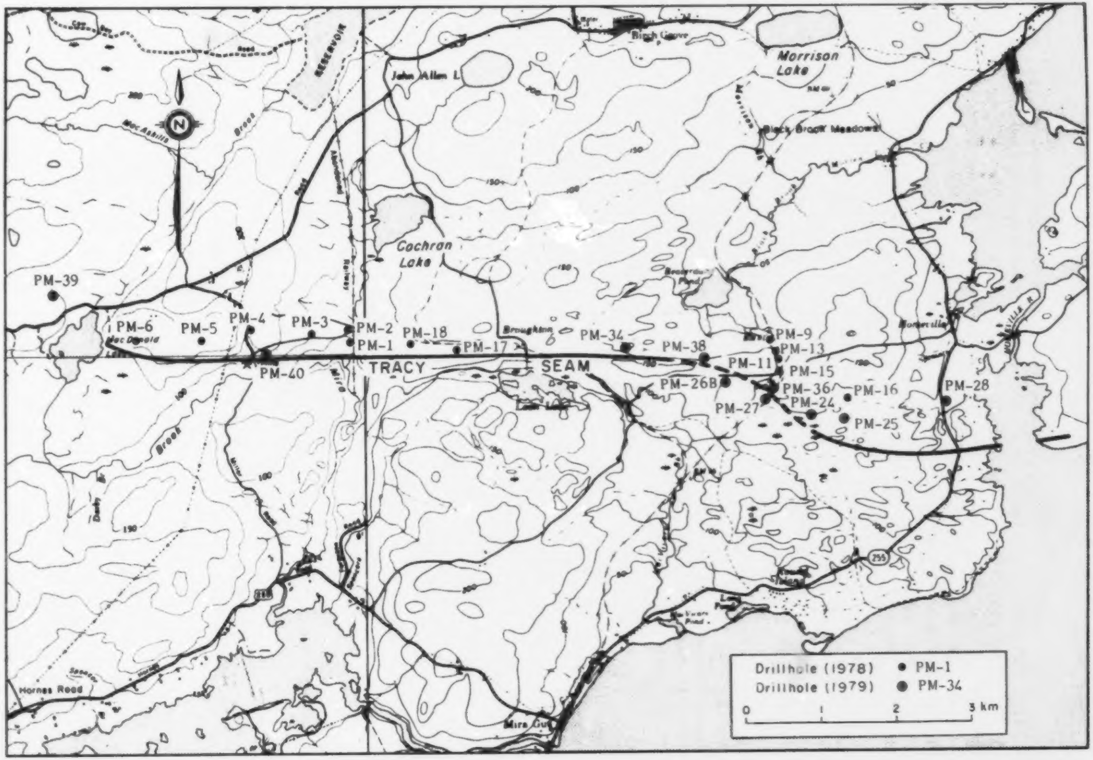


Figure 5. Location of drillholes on Tracy seam, Port Morien district.

Tracy Seam

The outcrop of the Tracy seam was further delineated by ten drillholes (Figure 5). Results of the drilling indicate a flexure in the Tracy seam east of Loon Lake with a decrease in dip from 10° to 7°. One hole (PM-39), west of MacDonald Lake, intersected a seam that is tentatively called the Tracy seam. The thickness is 0.43 m as compared with 1.16 m found east of the lake. If the coal intersected in hole PM-39 is the Tracy it indicates a rapid thinning of the seam in a westward direction. For tonnages at various strip ratios see Table 3.

Table 3

Strip Ratios	10:1	12.5:1	15:1	20:1
Tonnages of in situ coal (metric tonnes)	2,249,806	2,798,650	3,341,144	4,441,553

The average analyses for the Tracy seam for ash and sulphur are 11.14% and 5.90% respectively with a calorific value of 12,806 Btu/lb.

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ST. ROSE COAL BASIN

E. Smith

INTRODUCTION

Early in 1979 the Nova Scotia Department of Mines and Energy began a drill program in the St. Rose area to delineate further resources. The area is currently under lease to the Evans Coal Company and is being worked by a room and pillar operation by the same company. The product is almost exclusively sold to the Nova Scotia Power Corporation.

The small synclinal basin contains five seams, numbered consecutively 1 through 5, the No. 5 seam historically being the most productive and the one currently being worked.

To date (November, 1979) four drillholes have intersected the No. 5 seam outlining a further 1,899,453 metric tonnes of measured coal. The coal is characteristic of the Cape Breton coalfields, showing average analyses of 6.40% sulphur, 11.21% ash and 3.5% moisture.

LOCATION

The St. Rose coalfield is located on the western coast of Cape Breton Island and is the northernmost coalfield in a series that extends from Port Hood in the south, to St. Rose-Chimney Corner in the north. The area is located approximately 15 km north of the town of Inverness on Route 19. The areal extent of the St. Rose coalfield is approximately 5 km^2.

HISTORY

The geology of the St. Rose-Chimney Corner area was first studied by H. Fletcher during the years 1880-1882. The summary of his report may be found in the Geological Survey Report of Progress 1885.

In 1943 Dr. W. A. Bell of the Geological Survey of Canada carried out a study along the coastline from Broad Cove to Margaree Harbour and proved by fossil content that the St. Rose and Chimney Corner coalfields are contiguous.

Further work was done in 1942 by Dr. D. J. MacNeil, but he confined his studies mainly to the Windsor Group. Also in 1948, H. L. Cameron published a paper on the Cheticamp-Margaree map areas.

GENERAL GEOLOGY

The seams in the St. Rose area are contained in a synclinal trough which is bound to the west by the St. Rose Fault, which roughly parallels the coastline, and to the north by one in a series of five faults which separate the St. Rose-Chimney Corner portions of the coalfield. To the east the coalfield extends little more than 0.5 km from the Margaree-Inverness highway. The field is covered with thick drift, with 25 to 30 m not uncommon. The five seams do not outcrop, but have all been identified by diamond drilling (Figure 1).

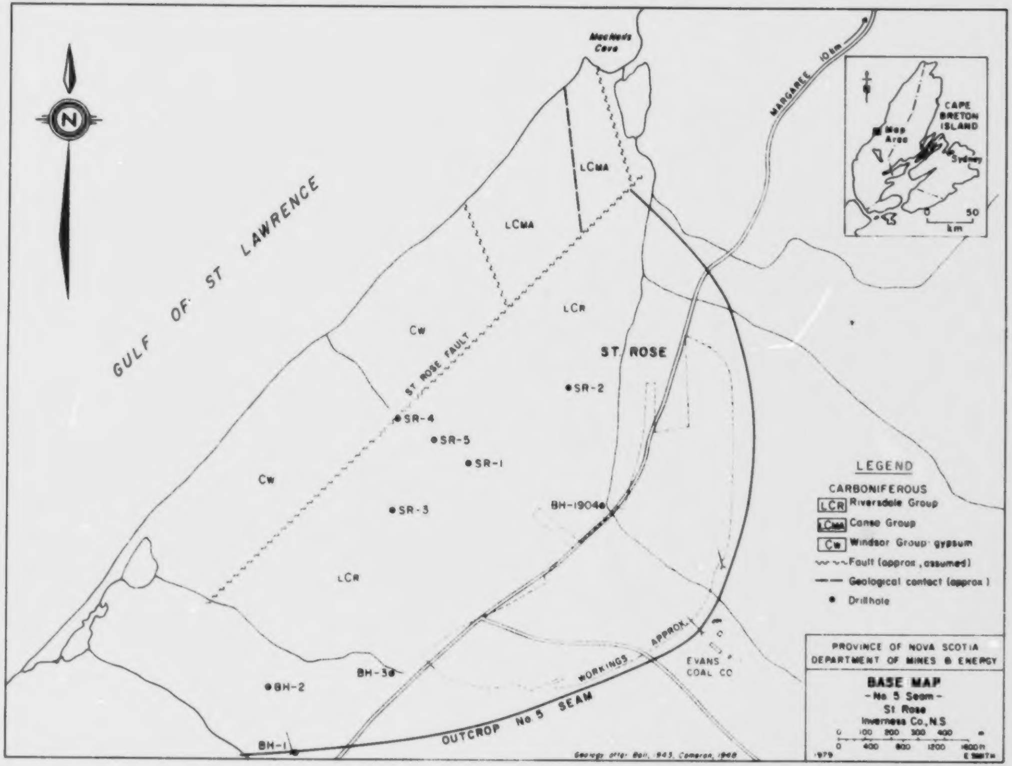
GULF OF ST LAWRENCE
N
MacNeils Cove
MARGAREE 10 km
CAPE BRETON ISLAND
Map Area
Sydney
0 50 km
LCMA
LCMA
LCR
Cw
Cw
LCR
ST ROSE FAULT
ST. ROSE
SR-2
SR-4
SR-5
SR-1
SR-3
BH-1904
BH-3
BH-2
BH-1
OUTCROP No 5 SEAM
WORKINGS APPROX.
EVANS COAL CO
LEGEND
CARBONIFEROUS
LCR Riversdale Group
LCMA Canso Group
Cw Windsor Group: gypsum
Fault (approx., assumed)
Geological contact (approx.)
Drillhole
PROVINCE OF NOVA SCOTIA
DEPARTMENT OF MINES & ENERGY
BASE MAP
- No 5 Seam -
St Rose
Inverness Co., N.S.
0 100 200 300 400 m
0 400 800 1200 1600 ft
1979
E SMITH
Geology after Bell, 1943, Cameron, 1968

Figure 1

Rocks of the Riversdale Group form the St. Rose coal basin. The sequence is typically composed of massive grey sandstone, interbedded with grey and red shales. Near the top of the group are five coal seams numbered 1 through 5. Two seams have been mined, the No. 2 and currently the No. 5. The dip of the eastern limb of the synclinal structure varies from 22° at the coal crop, to 12°, 600 m downdip in a westerly direction.

EXPLORATION AND COAL QUALITY

Other than regional geological studies by Fletcher, 1885; Bell, 1943; and Cameron, 1948, exploration in the St. Rose area was very limited, being primarily done by diamond-drill holes in the early 1900's as an aid to mining which has been carried out in the area since 1916. The original mining in the area was carried out on the No. 2 seam, but in recent years the No. 5 seam has been the main producer in the field.

In the spring of 1979, the Nova Scotia Department of Mines and Energy initiated a drilling program to outline further resources in the No. 5 seam and to delineate any additional resources within the basin.

To date four diamond-drill holes have penetrated the No. 5 seam. These holes were placed approximately 300 m ahead of the present workings of the Evans Coal Company in a line roughly parallel to the known strike.

The first diamond-drill hole (Figure 2), SR1, intersected the No. 5 seam at 843'7" to 853'7" and gave the following chemical analyses:

Depth	Moist %	Ash %	Vol %	FC	Sul %	C.V. Btu	FSI
843'7"-844'7"	3.03	18.10	32.68	46.19	8.10	10,974	1
844'7"-845'7"	3.45	7.39			5.62		3.5
845'7"-846'7"	3.41	7.47	36.53	52.59	5.92	12,517	4
846'7"-847'7"	3.71	6.82			5.30		2
847'7"-848'7"	4.07	6.53	34.57	54.83	5.10	12,593	1.5
848'7"-849'7"	3.65	11.75			4.48		2
849'7"-850'7"	4.06	10.51	34.50	50.93	6.22	12,021	1.5
850'7"-851'7"	2.86	19.40			7.15		1
851'7"-852'7"	3.36	24.19	31.12	41.36	7.31	10,049	1
852'7"-853'7"	3.45	28.17			8.84		1

Diamond-drill hole SR2 intersected the No. 5 seam at 816'9" and cut 8' of coal and hole SR3 intersected the No. 5 seam at 830'6" and cut 7' of coal (Figure 2). In all these holes, the remaining seams are considered subeconomic at this time. Analyses of these two drillholes follow:

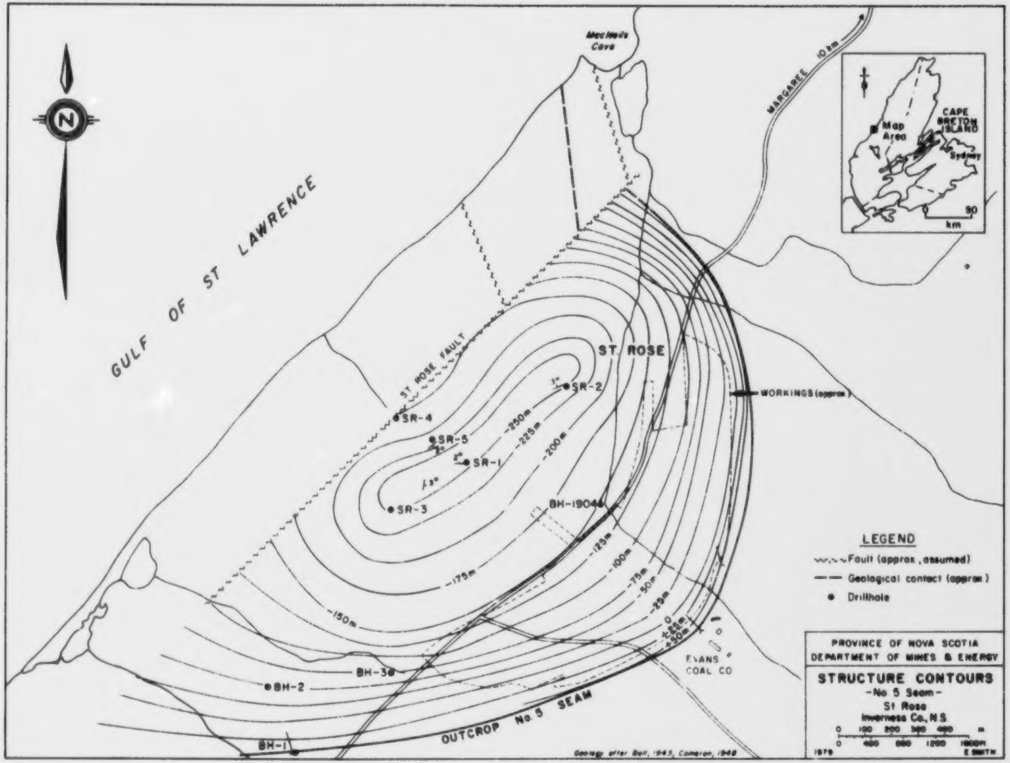
GULF OF ST LAWRENCE
N
MacNeils Cove
MARGAREE 10 km
Map Area
CAPE BRETON ISLAND
Sydney
0 90 km
ST ROSE
ST ROSE FAULT
SR-1
SR-2
SR-3
SR-4
SR-5
BH-1
BH-2
BH-3
BH-1904
WORKINGS (approx)
-250m
-225m
-200m
-175m
-150m
-125m
-100m
-75m
-50m
-25m
0
+25m
+50m
EVANS COAL CO
OUTCROP No. 5 SEAM
LEGEND
Fault (approx, assumed)
Geological contact (approx)
Drillhole
PROVINCE OF NOVA SCOTIA
DEPARTMENT OF MINES & ENERGY
STRUCTURE CONTOURS
-No 5 Seam-
St Rose
Inverness Co, N S
0 100 200 300 400 m
0 400 800 1200 1600 ft
1979
E SMITH
Geology after Bell, 1945, Cameron, 1948

Figure 2

SR2

Depth	Moist %	Ash %	Vol %	FC	Sul %	C.V. Btu	FSI
816'9"-817'9"	3.83	34.41	25.33	36.43	5.50	8,539	1
817'9"-818'9"	4.87	9.09			6.33		3.5
818'9"-819'9"	4.84	10.54	32.96	51.66	6.94	11,770	1
819'9"-820'9"	4.59	9.58			6.40		1.5
820'9"-821'9"	5.07	9.30	33.11	52.52	5.64	11,986	2.5
821'9"-822'9"	4.76	9.62			6.00		1.5
822'9"-823'9"	4.68	10.32	32.32	52.68	6.46	11,917	2.5
823'9"-824'6"	5.02	22.86			7.61		1

SR3

Depth	Moist %	Ash %	Vol %	FC	Sul %	C.V. Btu	FSI
830'6"-831'6"	2.07	14.87			7.36		1
831'6"-832'6"	2.66	8.87			5.36		2
832'6"-833'6"	2.35	7.90			5.92		1.5
833'6"-834'6"	2.42	10.22			5.12		1.5
834'6"-835'6"	2.69	10.50			5.62		1
835'6"-836'6"	2.73	7.56			5.48		2.5
836'6"-837'5"	2.22	25.35			8.24		1

Drillhole SR4 intersected gypsum of the Windsor Group at 357' after first passing through the St. Rose Fault. SR5 intersected 7' of coal at 742'. Analyses have not yet been completed on this drillhole.

The resources of the St. Rose coalfield were calculated using the following parameters: measured resources using 500' areas of influence around observation points; indicated using 1000' areas of influence; and inferred using 1500' areas of influence. The field was divided into areas. Measured resources comprise areas A, B and C; this being done due to different thicknesses of coal in each area. Indicated resources are contained in area D and inferred resources in area E (Figure 3, Table 1).

Table 1

Coal resources No. 5 seam
(metric tonnes)

Seam	Thickness	Area	Measured	Indicated	Inferred
No. 5	8'	A	672,379		
No. 5	8'	B	691,869		
No. 5	7'	C	535,205		
No. 5	7'	D		982,911	
No. 5	7'	E			240,081
Total			1,899,453	982,911	240,081

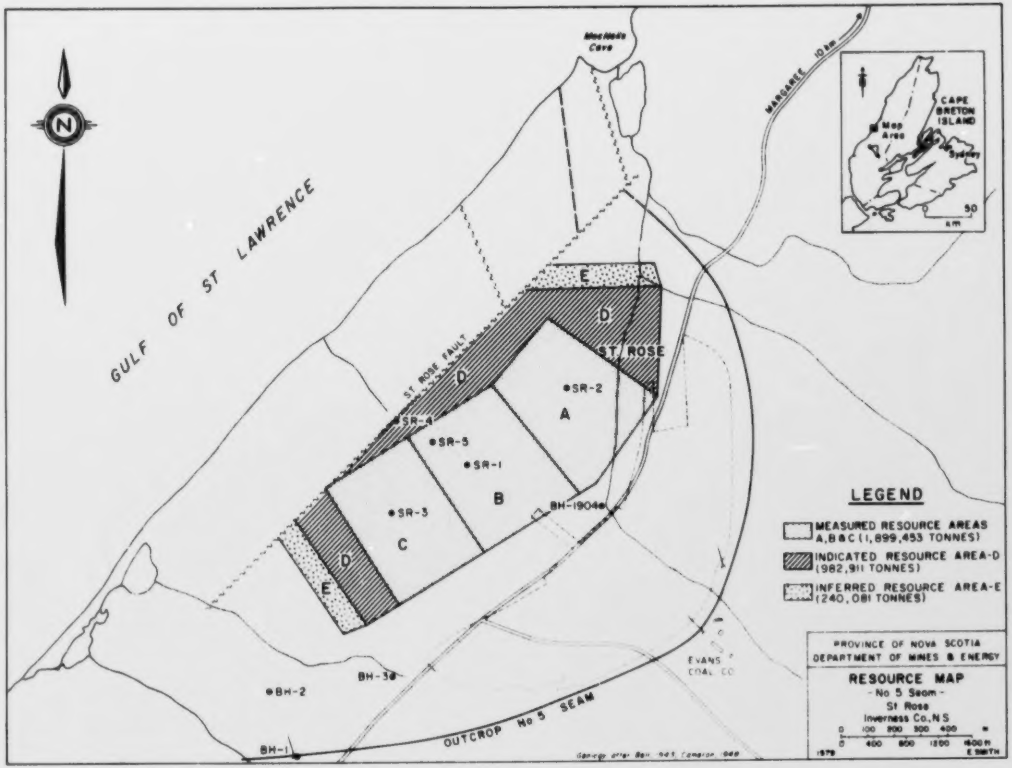
N
GULF OF ST LAWRENCE
Macleods Cove
MARGAREE 10 km
CAPE BRETON ISLAND
Map Area
Sydney
50
km
ST ROSE FAULT
ST ROSE
E
D
A
B
C
D
D
E
•SR-2
•SR-4
•SR-5
•SR-1
•SR-3
BH-1904•
BH-3•
•BH-2
BH-1
OUTCROP No 5 SEAM
EVANS COAL CO
LEGEND
☐ MEASURED RESOURCE AREAS A,B&C (1,899,453 TONNES)
▨ INDICATED RESOURCE AREA-D (982,911 TONNES)
░ INFERRED RESOURCE AREA-E (240,081 TONNES)
PROVINCE OF NOVA SCOTIA
DEPARTMENT OF MINES & ENERGY
RESOURCE MAP
- No 5 Seam -
St Rose
Inverness Co., N S
0 100 200 300 400 m
0 400 800 1200 1600 ft
1979
E SMITH
Geology after Bell 1945, Cameron 1948

Figure 3

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COAL EXPLORATION IN THE SPRINGHILL COALFIELD

J. H. Calder

INTRODUCTION

Four separate areas were investigated during 1979 in the Springhill coalfield. The bulk of the program was involved in diamond drilling. Although the Springhill coalfield has been extensively mapped by previous geologists, inconsistencies between diamond drilling results and previously conceived models of the structure and stratigraphy of the Springhill coalfield have prompted additional mapping in the key area of the anticlinal axis.

The four areas investigated by diamond drilling and mapping were: (1) the major seams south of all previous workings (south of the Athol Road and northwest of Leamington); (2) the F (Ward, 1979) group of seams overlying the No. 3 seam on the north limb of the anticline; (3) the No. 2 seam north of the workings in the Aberdeen slope; and (4) coals A, B, and C (Ward, 1979) downdip of outlined potential open-pit operations in the Rodney area (the latter drilling program is ongoing, hence inconclusive at time of writing).

GENERAL GEOLOGY

The Cumberland coal basin is situated within the larger Cumberland basin of deposition, and comprises the Joggins-Chignecto, Saltsprings, Oxford, and Springhill coal districts. The Cumberland coal basin contains 5200 m of terrestrial sediments consisting of the Mississippian Canso; Pennsylvanian Riversdale; and Cumberland Groups. In places, the older marine rocks of the Windsor Group concordantly underlie or pierce these terrestrial sediments. The Cumberland Group covers virtually the entire surface area of the Cumberland coal basin.

The basin structure is represented by the Athol Syncline, the axis of which trends from north of Springhill southwesterly through Apple River to the Bay of Fundy (Figure 1). The Springhill coalfield lies on the south limb of the Athol Syncline, where most of its coal seams dip westerly into the basin. Palynological investigations (Hacquebard and Donaldson, 1963) have determined the Springhill coal measures to be of Westphalian B age.

STRATIGRAPHY

The sediments of the Cumberland coal basin were largely derived from the Caledonia uplands to the northwest and the Cobequid Highlands to the south (Shaw, 1951). The sediments of the coal-bearing Cumberland Group attain a maximum thickness of 3600 m in the axial region of the basin. Various authors have chosen to subdivide the Cumberland Group into four or five facies. Shaw (1951) subdivided the Cumberland Group into five lithological facies. These facies do not represent time units, rather they exhibit distinct megascopic aspects. They are a) lower coarse facies; b) lower fine coal-bearing facies; c) middle fine non-coal-bearing facies; d) upper coarse facies; and e) upper fine facies.

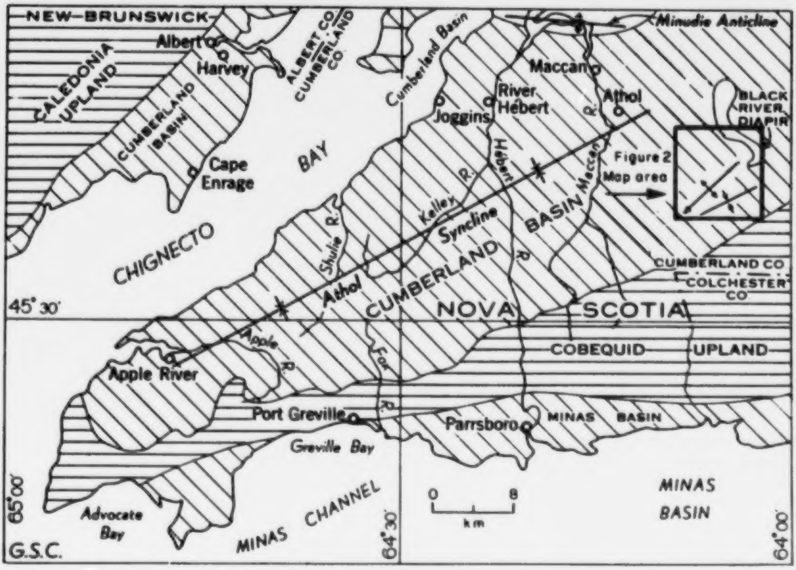

Figure 1. Principal structures of the Cumberland coal basin. Location of area mapped - Springhill coal basin (modified after Copeland, 1959).

Studies conducted during 1977-79 may lead to the redivision of facies b) and c) into three facies, pending the completion of a 1:10,000 geological map of the Springhill coalfield. Tentatively these will include a) a predominantly interbedded sequence of silts, sands and thin conglomerate beds; b) the major coal bearing zone; and c) an upper red bed sequence hosting several thin coal seams above the No. 3 seam. This reclassification will aid in future exploration in the Springhill area, as it will allow more detailed stratigraphic correlation in the southern part of the coalfield. It is however, contingent upon the correlation of strata on the south and north limbs of the Springhill Anticline.

At least 43 coal seams are recognizable in the Springhill coalfield over a stratigraphic section of 800 m. Of these, five were mined extensively on the north limb, these being (oldest to youngest) the Nos. 6, 7, 2, 1 and 3 seams (Figure 2). The five seams have an average stratigraphic separation of 335 m. The stratigraphic position of minor coal seams in the southwestern part of the area is uncertain. Various names have been given these seams in the past, among them the Golden, Canning, Dan MacLeod and Barlow.

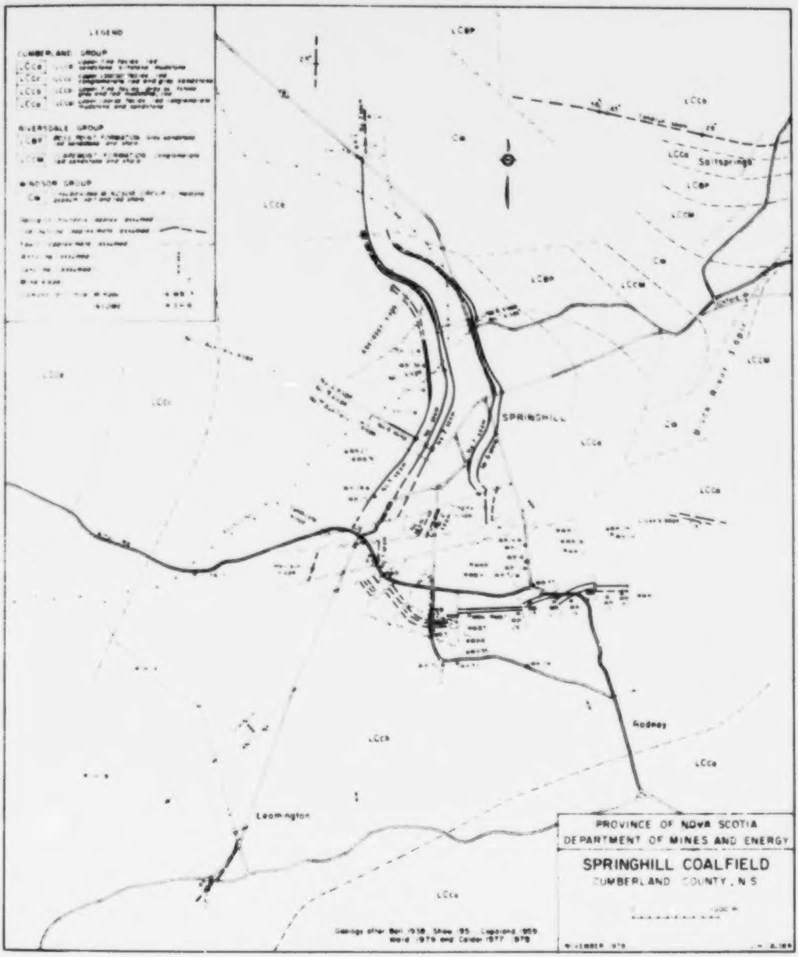

Figure 2. Geology map of Springhill coalfield.

The youngest reddish-brown mudstones lie approximately 130 m above the No. 3 seam in the northcentral region, although the interval apparently decreases markedly in a northerly direction. These beds are particularly useful in correlations pertaining to the No. 3, and younger seams.

STRUCTURAL GEOLOGY

The structural geology of the Springhill coalfield is complex. Although historically interpreted as a plunging anticline, the structure of the entire southern area (referred to as the south limb) remains largely unknown. Assuming that the Springhill coalfield is a plunging anticline, the south limb has undergone deformation either through dramatic uplift (with subsequent erosion), through strike-slip faulting of great displacement, or through major thrust faulting. The deformation and/or erosion may account for the absence of many of the major seams on the south limb. The interpretation of the intense structural geology is further complicated by the fact that seams cannot be correlated through palynological means.

The general model of a plunging anticline is probably correct, however the nature of the severe deformation of the anticlinal axis is unknown at this time. The Springhill coalfield has been deformed by the Black River or Claremont diapir to the northeast. The resulting anticline plunges southwesterly at 10° to 20°. A poorly defined syncline trending east-northeast runs from Rodney to Leamington, where it may die out near the anticlinal axis. It is believed that the syncline resulted partly from lateral compression contemporaneous with the formation of the anticline. Along the plunging nose of the Springhill Anticline the dip of the beds gradually decreases to less than 15° as deformation due to the diapir lessens. The dip of beds in the north limb steepens northerly from 30°W to 65°W due to local diapiric effects of Windsor evaporites east of the Aberdeen slope.

Within the north limb the beds are deformed by a monoclinal flexure near the -305 m level in the No. 2 seam. Minor faulting occurs in places within the monocline. The beds on the south limb dip on the average, at 24°S, apparently becoming shallower at depth southerly.

The nose of the Springhill Anticline is severely cut by normal faults. The dominant faults dip 65° to 72° and strike slightly obliquely to the anticlinal axis. This faulting makes correlation across the anticline very difficult.

DEPOSITIONAL ENVIRONMENT OF COAL SEAMS

The Springhill coal measures were formed in a tectonically active basin. Hacquebard, Birmingham and Donaldson (1967) described the Springhill coals as being deposited in a wide, level lacustrine basin of diapiric origin. It is useful to compare the lithology of the Pictou coalfield, a well researched lacustrine coal basin (Hacquebard and Donaldson, 1969), with the complex lithology and coal petrography of the Springhill coalfield. The dissimilarity of lithologies in the Springhill and Pictou coalfields points to different environments, even though the mode of deposition of coal seams may have been similar. Whereas the Pictou coals are characteristically dull, the Springhill coals have a characteristic intermediate lustre.

The dominant sediment in the Pictou coalfield is a varvelike, uniformly thinly laminated black shale. In addition, there is a definite scarcity of sandstones, pointing to a truly lacustrine environment. In Springhill, there are very few varvelike thinly laminated shales, with a complex suite of sandstones, siltstones, and mudstones, suggesting a slightly higher energy, much less stable environment than Pictou (perhaps fluvial).

The phenomenon of splitting, or intercalation of inorganic sediments within the Springhill coals is attributed to tectonic activity in the form of diapiric upflow during deposition. Diapiric activity of Windsor evaporites contemporaneous with peat accumulation in the northern region may have caused an uncharacteristically high (4%) sulphur content in the No. 2 seam. Subsequent upflow probably lowered the groundwater level below that required for peat-forming vegetation thus terminating the No. 3 seam in this area. Similar activity is assumed to have taken place on the anticlinal axis, where sulphur contents greater than 3% have been encountered.

Stable peat accumulation took place westward from the seam outcrops on the north limb of the anticline, apparently widening deeper in the coal basin away from the influence of diapiric activity. The low groundwater environment allowed the development of a forest-swamp environment. These relatively dry conditions were occasionally interrupted by sudden flooding, as in the Pictou coalfield (Hacquebard, et al., 1967).

The depositional environment of the Springhill coals was more complex than a purely lacustrine one, and can perhaps be described as a wide, level, limno-estuarine basin of diapiric origin. Megascopic petrography suggests that autochthonous deposition probably occurred in the northcentral district, with hypautochthonous deposition near the basin margins and in the south.

SUMMARY OF EXPLORATION RESULTS

I. DDNSSH-8 and -9:

Two diamond-drill holes were situated north of the Springhill or Claremont anticlinal axis, and south of all previous mine workings (Figure 2). DDNSSH-8 reached a depth of 1614', while DDNSSH-9 was terminated at 1294'. The purpose of the investigation was to intersect the Nos. 3 and 1 seams at depth to delineate a block of coal suitable for underground mining.

Due to the variations in lithologies and coal seam characteristics, correlations between the two holes are indefinite. The abundance of sandstones and a definite lithological change in DDNSSH-8 reflected on the natural gamma log below the 1210' depth are not apparent in DDNSSH-9. It is felt that the increase in channel sandstones in DDNSSH-

8 may be the effect of tectonic activity (uplift) to the southwest. The section of DDNSSH-8 below 1210' exhibits similar lithological features to the strata beneath coal C on the south limb.

In DDNSSH-8 only one well developed seam was intersected along with several shaly coal seams of lesser thickness. The seam was intersected from 1158'10"-1165'3". It contains two coaly shale partings: a 0'6" parting at 1159'6"; and a 0'10" parting at 1161'2". The lower 3'3" has a mean ash content of 24.25%.

In DDNSSH-9, three well developed seams were encountered. An 8'3" seam comprising two leaves was intersected at 798'7". The upper leaf (3'4") has a mean ash content of 24.81%. The lower leaf (4'0") has a mean ash content of 20.86%. The two leaves are separated by a shale parting 0'11" thick. A 5'0" seam intersected at 1203' has a mean ash content of 21.26% from 1204'-1208'. Coal, 4'9" thick, containing a 7" shale parting intersected at 1261', has a mean ash content of 13.62%. (For proximate analyses, see Table 1).

II. DDNSSH-10, -11 and -12:

In 1979 B. Ward, Wimpey Laboratories, U.K. reported the following: "It is believed that WB36, located in the zone of intact coal north of the No. 3 seam workings, did not penetrate both leaves of the split No. 3 seam. The upper seam in WB36, correlated with coal F, showed a true thickness of 3'9" and ash content of 10%." It was this erroneous assumption which lead to the investigation of the F seam. Three drillholes, DDNSSH-10, -11, and -12, were drilled along strike and it was concluded that WB36 intersected the upper and lower leaves of the No. 3 seam.

DDNSSH-10 was drilled to a depth of 280', DDNSSH-11 to 183', and DDNSSH-12 to a depth of 340'. All three drillholes intersected both the F coals and the No. 3 seam.

The F seam comprises a group of thin seams approximately 30 m stratigraphically above the No. 3 seam.

The stratigraphy above the No. 3 seam has been correlated from WB34 to DDNSSH-12, a strike length of 1920 m. Although it is of a relatively short stratigraphic interval, this section represents the most detailed correlation of strata currently available on the north limb of the Anticline. In addition to WB36, DDNSSH-12 intersected both leaves of the No. 3 seam north of workings on this seam. Both WB36 and DDNSSH-12 had only limited success in coring the seam, perhaps a reflection of highly fractured or cleated low ash coal. (For proximate analyses, see Table 1).

III. DDNSSH-13 and -14:

The object of this program was to intersect the No. 2 seam north of the workings in the Abderdeen slope.

Table 1

DDNSSH-8

SEAM	SAMPLE INTERVAL	ASH(%)	MOISTURE(%)	SULPHUR(%)	VOLATILE(%)	FIXED CARBON(%)	CALORIFIC VALUE Btu/lb
No. 3 ?	1158'10"-1159'6"	24.01	0.85	2.34	30.94	44.20	11,318
	1159'6" -1160'	76.84	0.36	1.50	-	-	-
	1160' -1161'2"	27.34	0.59	2.16	30.44	41.63	10,872
	1161'2" -1162'	82.09	0.22	1.96	-	-	-
	1162' -1163'	29.06	0.52	1.24	28.18	42.24	10,712
	1163' -1164'	31.08	0.61	1.98	-	-	-
	1164' -1165'	11.34	0.78	0.86	33.18	54.70	13,504
	1165' -1165'3"	22.64	0.67	4.90	-	-	-

DDNSSH-9

SEAM	SAMPLE INTERVAL	ASH(%)	MOISTURE(%)	SULPHUR(%)	VOLATILE(%)	FIXED CARBON(%)	CALORIFIC VALUE Btu/lb
No. 3 ?	799'9" - 801"	22.34	1.24	2.90	-	-	-
	801' - 802'	26.51	1.09	2.76	28.67	43.73	10,474
	802' - 802'10"	25.58	0.89	3.28	-	-	-
	803'8" - 805'	24.28	0.98	2.59	28.32	46.42	10,918
	805' - 806'	20.13	1.28	3.37	-	-	-
	806' - 807'	12.06	1.37	2.70	29.30	57.27	12,768
	807' - 808'	26.96	1.10	4.44	-	-	-
	1198'11"-1199'7"	21.41	0.66	1.60	-	-	-
	1200' -1200'8"	48.72	0.46	0.76	23.82	27.00	6,883
	1201'10"-1203'	42.80	0.51	0.78	-	-	-
	1203' -1204'	36.01	0.61	1.22	25.17	38.21	9,040
	1204' -1205'	24.27	0.74	2.00	-	-	-
	1205' -1206'	13.63	0.82	0.60	32.87	52.68	12,512
	1206' -1207'	23.17	0.69	0.68	-	-	-
	1207' -1208'	25.03	0.79	0.98	31.26	42.95	10,440
	1261' -1262'5"	12.21	1.02	1.60	31.26	55.51	13,044
	1263' -1264'4"	15.03	0.90	2.04			

DDNSSH-10

SEAM	SAMPLE INTERVAL	ASH(%)	MOISTURE(%)	SULPHUR(%)	VOLATILE(%)	FIXED CARBON(%)	CALORIFIC VALUE Btu/lb
No. 3	186'2"-191'2' (poor recovery)	7.38	3.37	1.44	31.26	57.99	13,010
				DDNSSH-13			
No. 2	615' -615'11"	28.59	1.80	4.52	29.08	40.53	9,900
	616'9"-617'6"	43.18	1.60	3.00	-	-	
	617'6"-618'6"	12.34	2.29	4.53	33.62	51.75	12,486
	618'6"-619'6"	33.78	1.99	3.62	-	-	
	619'6"-620'6"	24.23	1.95	4.04	27.42	46.40	10,588
	620'6"-621'6"	16.61	2.05	4.08	-	-	

DDNSSH-13 reached a depth of 641', and DDNSSH-14 was terminated at 495'. Both drillholes were drilled on a bearing of 090° at 45°.

DDNSSH-13 was positioned to intersect the Nos. 3, 1, and 2 seams. From results of drilling, it appears that the northern limit of deposition of the No. 3 seam was south of DDNSSH-13, and that the northern limit of deposition of the No. 1 seam was near the site of DDNSSH-13.

The No. 2 seam was intersected at a depth of 615' and is composed of 0'11" shaly coal, 0'11" shale and 5'1" coal, in places shaly. The mean ash content of the lower leaf is 21.74%. The uncharacteristically high sulphur content (4.07%) points to the existence of a gypsum hinterland during formation of the peat. DDNSSH-14 intersected the seam at 385'8", however, virtually no core was recovered. The hole was geophysically logged, as were all drillholes from DDNSSH-8 through - 14. The No. 2 seam in DDNSSH-14 appears to have a similar ash content to the intersection in DDNSSH-13. (For proximate analyses, see Table 1).

IV. DDNSSH-15:

This investigation is continuing at the time of writing. The purpose of the program is to intersect the coals A, B, & C downdip between holes WB5 and 7 to ascertain thickness and quality at depth.

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PEATLANDS PROJECT

W. Broughm

INTRODUCTION

The Nova Scotia Department of Mines and Energy is currently engaged in a preliminary evaluation of the Province's peat resources with emphasis on the availability of peat as a fuel for thermal generation.

More than 30% of the total world peat resources are located in Canada and preliminary assessment indicates that Nova Scotia has at least fifty million tons of fuel peat (Tibbetts and Fraser, 1978).

In several European countries it has become economically attractive to use peat as a fuel for power generation as well as the production of metallurgical coke. Over one hundred generating plants in Europe use peat as a fuel to supply some 7240 MW of electrical power. In addition, the Soviet Union is currently constructing a generating station that will generate more than 1000 MW of electrical power using peat as a fuel source (Tibbetts and Fraser, 1978).

Almost all of the provinces in Canada are currently evaluating their peat resources. New Brunswick has taken the lead in this evaluation and, in conjunction with a detailed evaluation of their resource, is designing a demonstration unit to generate electricity from peat.

Since not all peat deposits are fuel peat, the size of the deposits, their physical properties, transportation distances and the size of the thermal plant, have to be considered in developing a fuel peat industry.

There exists a need to evaluate peat deposits which are believed to have the required humification to be used as fuel peat, as well as have sufficient reserves within transportation range to justify construction of a new thermal plant or to supplement a thermal plant using several fuel sources.

To allow Nova Scotia to assess this energy resource, a plan was developed to be completed over the next several years.

WORK COMPLETED

Because only a very small percentage of the peat resources in Nova Scotia had been studied by previous workers (Sutherland and Shea, 1976; and Leverin and Cameron, 1949), the following work was carried out to properly evaluate the fuel peat resources of the Province:

(i) A review of all Nova Scotian peatlands previously studied.
(ii) Compilation of map showing approximate area and distribution of organic terrain in Nova Scotia.
(iii) Preparation and review of bibliography for peatlands.
(iv) Trip to New Brunswick to discuss survey methods.
(v) Study of airphoto interpretation techniques and preliminary interpretation and field check of selected areas.

Nova Scotia has several areas containing high concentrations of peat deposits (Figure 1). A study of the factors which control the economics of peatland development for fuel indicates that these areas contain resources large enough to warrent detailed investigation. A further encouragement is that climatic studies indicate Nova Scotia is one of the more favourable areas in Canada for natural drying in the mining of peat.

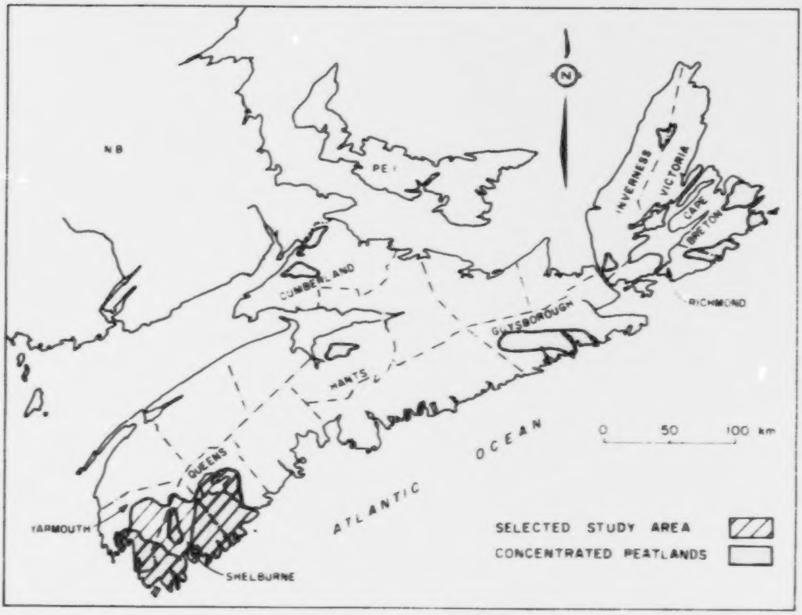

Figure 1. Location map - peatland areas of Nova Scotia.

It is felt that the inventory methods used in New Brunswick are compatible with the needs of a Nova Scotian inventory program and can be adopted with only slight modifications.

PROPOSED WORK

Areas being considered for detailed investigations include large portions of Guysborough, Shelburne, Queens, Yarmouth, Cumberland, Richmond, and Cape Breton Counties (Figure 1).

For the 1980 field season one area has been selected for study. The study area covers approximately 4600 km^2 extending from the area between Ponhook Lake and the South Shore in Queens County, through Shelburne County, to the shore of Lobster Bay, Yarmouth County (Figure 1).

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LAKE AND STREAM SEDIMENT GEOCHEMICAL SURVEYS

G. G. Richardson

INTRODUCTION

During the 1979 field season, neither stream nor lake sediment samples were collected. This was in order to relieve the laboratory of back-log of samples collected in the previous field season.

Base maps for two stream sediment and five lake sediment survey areas were prepared. Stream sediment data for eleven elements from the Port Hood map area were released on open file (OFR 409).

STREAM SEDIMENT GEOCHEMICAL SURVEY

The Port Hood map (Figure 1) covers an area of approximately 1100 km^2 (425 square miles). The area lies between longitudes 60°58' and 61°32', and latitudes 45°46' and 46°06', and includes NTS maps 11F/14 and parts of 11K/03, 11K/04, 11F/13 and 11F/15.

During the 1977 and part of the 1978 field seasons, 3500 stream sediment samples were collected from the Port Hood area. These samples were analyzed for the elements copper, lead, zinc, nickel, silver, cadmium, manganese, iron, uranium, molybdenum, mercury, barium, strontium, fluorine, and arsenic. With the aid of the Hewlett-Packard 3000 computer at St. Francis Xavier University, Antigonish, the data were verified, statistically analyzed and plotted. Geochemical maps for eleven elements were released on open file (OFR 409) on November 13th, 1979. Maps for cadmium, uranium, molybdenum and mercury were not released, but will be released pending completion of analyses.

Samples collected from the Port Hawkesbury area (Figure 1) are being analyzed and the data will be released upon completion of analyses.

LAKE SEDIMENT GEOCHEMICAL SURVEY

Some 2600 lake sediment samples were collected in 1977 and 1978 from five map areas in southwestern Nova Scotia (Figure 2). The samples were collected by A Bell 206 Jet Ranger helicopter from approximately 2500 lakes. The samples are being analyzed for copper, lead, zinc, nickel, cobalt, iron, manganese, molybdenum, magnesium, calcium, loss on ignition, mercury, arsenic and uranium. The data will be released upon completion of analyses.

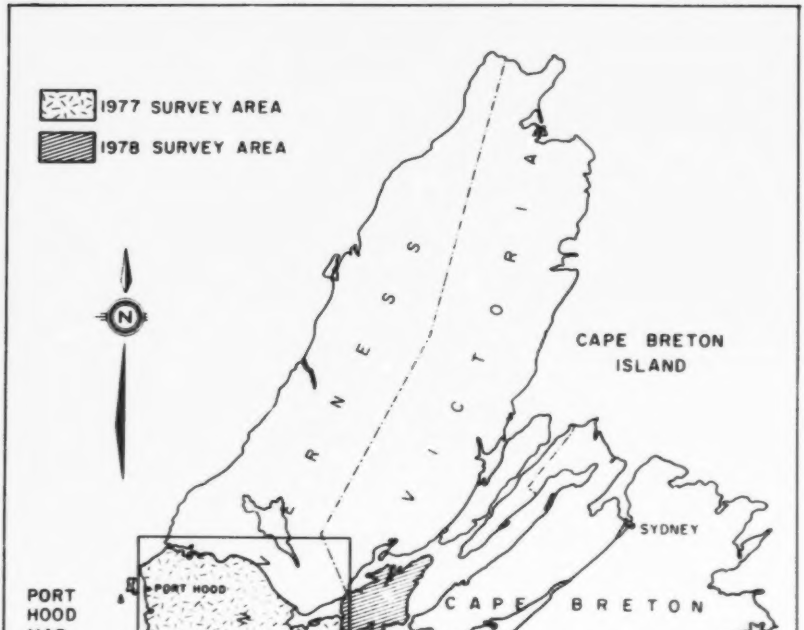

Figure 1. Stream sediment geochemical survey.

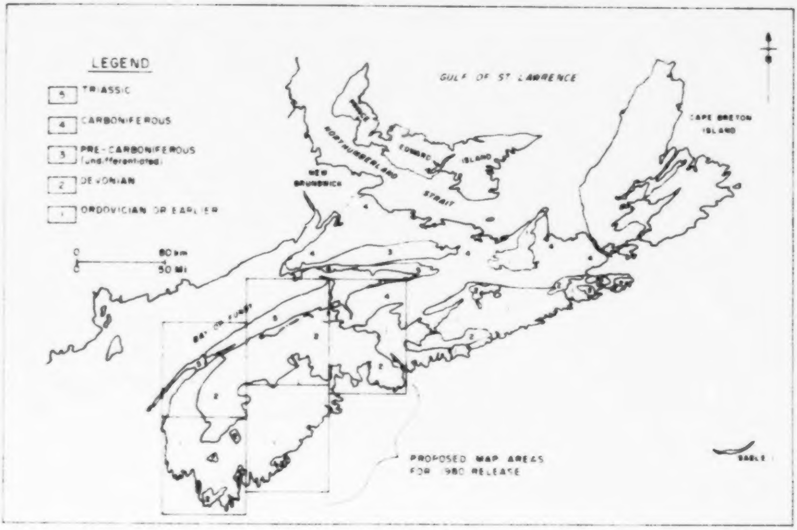

Figure 2. Lake sediment geochemical survey.

POLYMETALLIC TIN MINERALIZATION RELATED TO ACID MAGMATISM, SOUTHWESTERN NOVA SCOTIA*

A. K. Chatterjee

SUMMARY

Detailed metallogenetic investigation of polymetallic tin mineralization associated with the granitoid rocks of the Davis Lake (Longitude 65°43'W, Latitude 44°04'55"N) area of southwestern Nova Scotia calls attention to a type of tin deposit that may be widely distributed in Nova Scotia. The nature and style of mineralization is strikingly similar to many well documented tin deposits in the USSR, Spain, Central Europe, Eastern Australia and Tasmania.

The Davis Lake granite complex shows two types of compositional and textural zoning. In the first case, the parental biotite granite tends to become fine grained, more potassic and silicic. In the second and general case, the granites tend to become coarser grained, more sodic and slightly less silicic. The first group includes porphyritic biotite granite, argillized and sericitized granite and greisenized granite. Albitized granite, albitites, albitite breccia and greisens constitute the second group. Representative chemical analyses, norms, normative proportions and selected trace element data are given in Table 1.

The porphyritic biotite granite is generally pale grey to dark grey in colour and is massive to weakly foliated. Most of the conspicuous phenocrysts of the rock are K-feldspar, but locally quartz also forms phenocrysts and the rock has a "quartz porphyry" aspect. The rock is composed generally of nearly equal portions of quartz, plagioclase and perthitic K-feldspar which together make up about 95% of the rock. Biotite, muscovite, fluorite, apatite, zircon and rutile in approximate decreasing order of abundance, comprise the accessories.

The argillized and sericitized granite is nearly massive, homogeneous granular biotite-muscovite granite. In thin section, the texture of the rock is hypidiomorphic granular, and modal analyses show that generally more than 95% of the rock consists of perthitic microcline, albite and quartz, in that order of abundance. Biotite, muscovite, fluorite, topaz, cassiterite and minor opaque minerals are the main accessory minerals.

The greisenized granite is fine- to medium-grained, xenomorphic (except for K-feldspar) and equigranular. It appears to be associated with the hydrothermal introduction of quartz-topaz-fluorite-cassiterite and sulphide veins. Fresh surfaces are very light grey because of abundance of quartz and scarcity of biotite. Thin quartz veinlets are common and are discontinuously sheeted often interfingering in places.

In hand specimen, the typical albitized granite is pale grey, massive, sugary textured, and has no visible mafic minerals. Occasionally some evidence of cataclasis is also seen. The albitized granite consists

* Paper presented at the Metallization Associated with Acid Magmatism meeting at Exeter, United Kingdom; to be published in a symposia volume; John Wiley and Son Ltd.

Table 1

Representative chemical analyses, norms, normative proportions, selected trace elements of rocks from Davis Lake igneous complex, southwestern Nova Scotia. Analyses 1 and 2 biotite granite, 3 and 4 sericitized granite, 5 silicified - sericitized granite, 6 and 7 albitized granite, 8 and 9 albitites, 10 albitite breccia, 11 muscovite-quartz greisen, and 12 greisenized-sericitized granite.

	1		2		3		4		5		6	
Oxides												
SiO_2	74.21	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Al_2O_3	13.31	[illegible]	12.87	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Fe_2O_3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
FeO	1.10	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MgO	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CaO	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Na_2O	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K_2O	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TiO_2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
P_2O_5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MnO	[illegible]		0.03		[illegible]		[illegible]		[illegible]		[illegible]	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
H_2O	[illegible]		[illegible]		[illegible]		[illegible]				[illegible]	
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Norm												
Q	36.17	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
C	1.57	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Or	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ab	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
An	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
En	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Fs	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Mt	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Il	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ap	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Norm. Ratios	1			2			3			4			5			6		
Or : Ab : An	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Q : Ab : Or	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
DI	[illegible]		[illegible]	[illegible]		[illegible]	[illegible]		[illegible]	[illegible]		[illegible]	[illegible]		[illegible]	[illegible]		[illegible]

Trace Elements	1	2	3	4	5	6
Ba	77	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Rb	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Sr	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Li	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
F	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Sn	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Zn	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
As	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

	1			2			3			4			5			6		
Ba : Rb : Sr	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

	[illegible]			[illegible]			[illegible]			[illegible]			11			[illegible]		
Oxides																		
SiO_2	73,56		[illegible]	[illegible]		[illegible]	75,60		(72,22)	75,60		(80,88)	73,78		(67,27)	62,30		(58,79)
Al_2O_3	12,42		[illegible]	[illegible]		[illegible]	[illegible]		(12,90)	12,00		(14,38)	13,60		(15,96)	21,08		(24,09)
Fe_2O_3	0,48		[illegible]	[illegible]		[illegible]	0,33		(0,28)	0,42		(0,35)	2,27		(1,21)	1,10		[illegible]
FeO	0,78		[illegible]	[illegible]		[illegible]	0,80		(0,71)	1,07		(1,74)	11,51		(13,20)	1,77		(1,66)
MgO	0,27		[illegible]	[illegible]		[illegible]	[illegible]		(0,32)	0,78		(1,08)	1,23		(1,56)	0,51		(0,74)
CaO	1,17		[illegible]	[illegible]		[illegible]	0,67		(0,66)	0,60		(0,60)	0,71		(0,81)	0,62		(0,63)
Na_2O	4,26		[illegible]	[illegible]		(11,58)	4,80		(8,88)	3,01		(10,05)	0,33		(0,68)	0,71		(0,61)
K_2O	1,80		[illegible]	[illegible]		(1,42)	3,07		[illegible]	3,06		(3,42)	5,08		(5,42)	5,19		(6,32)
TiO_2	0,12		[illegible]	[illegible]		(0,07)	0,12		(0,09)	0,21		(0,15)	0,10		(0,08)	0,31		(0,26)
P_2O_5	0,13		[illegible]	[illegible]		[illegible]	0,08		(0,09)	0,20		(0,16)	0,05		(0,09)	0,16		(0,13)
MnO	0,03			[illegible]						0,03			0,26			0,06		
CO_2	0,06		[illegible]	[illegible]		[illegible]	0,13		(0,22)	0,13		(0,15)	0,07		(0,10)	0,06		(0,07)
H_2O	1,80			[illegible]			0,78			1,13			2,70			1,86		
	100,12		(99,96)	[illegible]		[illegible]	98,62		(100,08)	99,73		(100,02)	94,83		(100,01)	98,81		(100,00)
Norm																		
Q	42,29		(33,08)	[illegible]		(31,33)	43,80		(40,44)	34,19		(17,48)	31,66		(31,09)	23,52		(22,79)
C	1,66		(3,78)	[illegible]		(6,67)	1,65		(1,81)	6,42		(4,74)	8,79		(9,50)	10,47		(11,44)
Or	11,08		(11,17)	[illegible]		(17,27)	10,10		(10,18)	19,20		(18,10)	29,37		(27,08)	31,58		(31,61)
Ab	32,28		(41,27)	[illegible]		[illegible]	41,70		(44,67)	31,00		(53,24)	3,03		(3,41)	29,44		(28,09)
An	4,78		(4,12)	[illegible]		[illegible]	0,56		(0,56)	2,92		(2,01)	2,36		(3,17)	1,77		(1,76)
En	0,17		(0,19)	[illegible]		[illegible]	0,38		(0,42)	1,07		(2,15)	2,58		(3,27)	1,31		(1,42)
Fs	0,88		(0,74)	[illegible]		[illegible]	1,56		(0,07)	2,26		(1,86)	20,84		(18,67)	1,78		(1,70)
Mt	0,70		(0,51)	[illegible]		[illegible]	0,58		(0,42)	0,99		(0,69)	4,33		(3,31)	1,97		(1,42)
Il	0,23		(0,17)	[illegible]		[illegible]	0,23		(0,17)	0,22		(0,29)	0,20		(0,16)	0,64		(0,47)
Ap	0,30		(0,28)	[illegible]		[illegible]	0,13		(0,17)	0,47		(0,42)	0,12		(0,12)	0,38		(0,34)
Norm Ratios																		
Qz Ab An	25,21	71,38	3,41	20,2	76,34	3,30	14,78	74,38	1,05	26,18	72,52	1,31	80,94	5,60	9,46	52,84	44,21	2,95
	(19,76)	72,90	(7,29)	21,28	77,44	1,29	(19,2)	80,54	1,00	(25,06)	73,60	1,28	80,46	10,11	9,41	(51,66)	45,68	2,88
Ab Or	46,09	41,80	12,12	11,38	68,77	19,85	45,63	47,73	10,64	21,68	57,57	20,77	55,54	5,23	42,43	38,84	32,42	38,75
	43,01	44,86	12,16	(12,08)	68,75	18,87	42,58	46,73	10,73	19,68	54,02	27,38	59,48	5,56	44,05	(26,75)	34,45	38,80
DI	91,81		(91,98)	93,63		(93,73)	96,86		(96,03)	88,59		(88,83)	60,38		(61,58)	81,55		(81,68)
Trace Elements																		
Ba		nd			37			12			110			nd			103	
Rb		208			776			317			415			471			1227	
Sr		67			55			77			63			7			23	
Li		35			394			47			292			194			88	
F		1,500			2,250			5,190			6,260			6,520			6,900	
Cu		33			187			151			1,830			3,121			1,117	
Y		22			8			26			33			38			96	
Nb		8			10			8			12						28	
Be		10			17			4			32			129			152	
Sn		19			50			38			378			15,500			1,630	
Zn		47			56			27			48			1,780			64	
Bi		nd			nd			nd			nd			38			18	
Ag		nd			nd			nd			4			23			11	
Qz Ab Or	5,8	91,8	8,1	15,9	86,7	4,4	12,2	71,4	16,3	22,08	67,67	17,3	0,8	98,8	0,8	2,6	95,6	1,8
[illegible]	42,6	49,7	7,7	69,4	12,2	18,3	60,3	14,3	19,6	94,71	3,62	1,68	98,3	0,3	1,0	93,46	5,78	0,73

(*) Numbers in brackets are cation proportions.
I Trace element concentration in ppm.
nd = not determined.

chiefly of quartz, albite, perthitic potassium feldspar and muscovite, generally in that order of abundance. Fluorite, topaz and cassiterite are sparse and some samples contain disseminated sphalerite, chalcopyrite, pyrite, pyrrhotite and euclase.

The albitites are leucocratic, coarse grained, porphyritic, albite-quartz-muscovite rocks. They are characterized by complete absence of K-feldspar. In the porphyritic variety crystals of albite, up to 3 cm in size or crystal clusters are set in a matrix of lath-like albites and quartz. Small amounts of interstitial quartz, biotite, muscovite, phenakite, bertrandite, cassiterite, apatite, fluorite and cryolite are often present. The albitites grade into albitite megabreccia (Figure 1). Mineralogically the breccia is similar to albitite except that quartz is more abundant. The presence of albitites and albitite breccia is rather unexpected with the granitoid rocks of the South Mountain batholith because magmatic albitites are generally associated with the alkalic carbonatite complexes. However, the (post orogenic-fold belt type) tin districts in Europe and the USSR are all characterized by albitized granites and/or albitites (Taylor, 1979). Taylor (1979) aptly pointed out "examples of albitites are rare outside of Europe and the USSR although this probably reflects the problems of recognition rather than an absence. The phenomenon has recently been noted at several points within the eastern Australian tin provinces" - after seven years of active exploration since the initial discovery of tin mineralization. The greisens range in colour from light grey to light honey, and are composed essentially of quartz, mica, topaz, cassiterite and fluorite. Metallic sulphides are finely disseminated, chiefly as pyrite, chalcopyrite, sphalerite, bornite, bismuthinite and molybdenite. Rarely, wolframite is seen associated with molybdenite.

The polymetallic tin mineralization in the granitoid rocks is found mostly as disseminations and quartz-cassiterite-sulphide veins. Though cassiterite has been identified in all the rock types of the area, economic concentrations are probably restricted to greisenized granite, greisens and albitite megabreccia (Table 1, analyses Nos. 10, 11, and 12). Associated sulphide minerals are pyrite, pyrrhotite, chalcopyrite, sphalerite, tetrahedrite, chalcostibite and polybasite. Other minerals of interest are native bismuth, native silver, euclase, phenakite, bertrandite, and topaz.

The selection of trace elements in the present study was based on their potential function to indicate the degree of specialization of the granitoid rocks and also as pathfinders for exploration purposes. A typical comparison of the level of concentration of Rb, U, F, Li, Sn and Be between the comagmatic suite of granodiorite (1) - adameltite (2) - alaskite (3) - aplite (4); and the geochemically specialized suite consisting of biotite-granite (5) - sericitized granite (6) - albitized granite (7) - albitite (8) is given below:

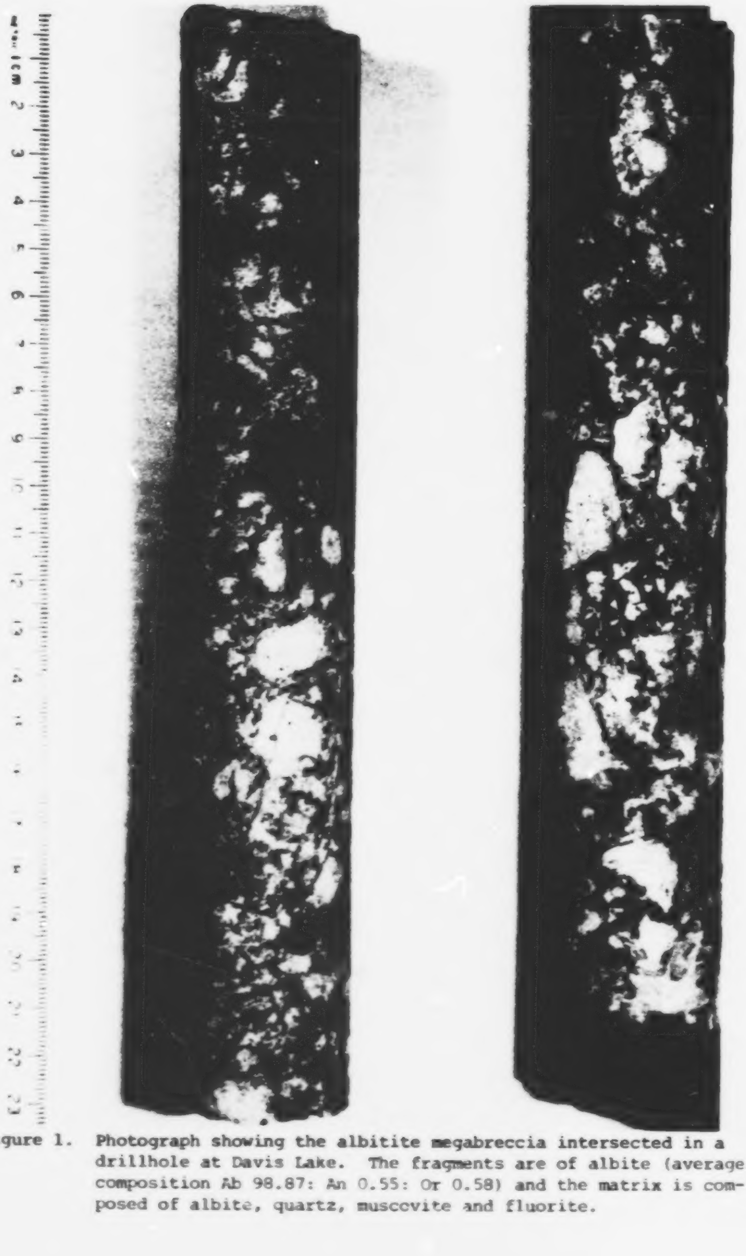
1 cm 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23

Figure 1. Photograph showing the albitite megabreccia intersected in a drillhole at Davis Lake. The fragments are of albite (average composition Ab 98.87: An 0.55: Or 0.58) and the matrix is composed of albite, quartz, muscovite and fluorite.

	Comagmatic suite n=12 South Mountain Batholith*				Specialized granite Davis Lake** n=12			
	1	2	3	4	5	6	7	8
Rb	159	216	252	292	750	798	878	563
U	(No Published Data)				22	28	26	32
F	1100	1300	1300	1600	3500	4200	4320	2250
Li	95	116	109	83	180	170	205	220
Sn	6	10	15	18	18	52	28	165
Be	7	7	7	10	13	27	18	30

*Data from Smith (1979)

**Albitite breccia, greisenized, granite and greisens are not included.

All values are in ppm
n = average number of samples

Clearly, the granitoid rocks of the Davis Lake area are geochemically specialized in Rb, U, F, Li, Sn and Be. Similar trends of geochemical specialization are well documented in the literature for the tin district of Erzgebirge (Tischendorf, 1973), Tasmania (Groves, 1978), E. Transbaikalia (Tauson, et al., 1978), Mongolia (Pyatenko, et al., 1967), E. Austrialia (Hesp, 1974), France (Burnol, 1974), and Czechoslovakia (Klominsky and Absolonova, 1974).

On the basis of petrographical, mineralogical and geochemical analyses of rocks (n=120) and minerals (n=200) it is concluded that the granitoid rocks of the Davis Lake area are metasomatized rocks and the majority of the rock-forming minerals do not show strong evidence of magmatic equilibrium. The polymetallic tin mineralization is believed to have been formed from a dense, fluorine-rich fluid which separated continuously from magma at a late stage of crystallization. As the solution cooled and reacted with the wall rock, albitization yielded to greisenization with attended metal deposition.

The trace element distribution of Rb, U, Li, F, Sn and Be in the granitoid rocks of the South Mountain batholith is recommended as the most reliable criteria for differentiating metasomatized and magmatic rocks. The metasomatized rocks are potentially favourable for the Sn-W-U-Be mineralization.

The author wishes to express his gratitude to Lacana Mining Corporation for permission to sample and examine the drill core for the present study.

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POLYMETALLIC TIN MINERALIZATION, PEARL LAKE AREA, YARMOUTH COUNTY, SOUTHWESTERN NOVA SCOTIA

A. K. Chatterjee

SUMMARY

A diamond drilling program was carried out by Kerr Addison Gold Mines Limited during the 1977-78 field season in the Pearl Lake area, (Longitude 64°43'W, Latitude 44°04'53") Yarmouth County, southwestern Nova Scotia. The details on the exploration program are available in the assessment report (AF 20P/13B 07-R-10(01)). The resulting drill core was given to the Nova Scotia Department of Mines and Energy in December 1978.

Tin Mineralization:

Various types of polymetallic sulphide associations in the drill core were identified as vein fillings by a geologist of Kerr Addison Gold Mines. The details are given in the report (NSDME file AF 20P/13B 07-R-10(01)). However, no mention of Sn mineralization in the drill core was made.

The country rock in the Pearl Lake area is an interbedded sequence of slates and quartzites of the Meguma Group. The regional grade of metamorphism appears to be above garnet isograd. Fracture fillings and vein types (stock work ?) of tin mineralization were identified in DDH Nos. 3 and 5 (only drillholes examined). The veins range in thickness from less than 1 cm to more than 18 cm with an average thickness of around 6 cm. Veins thicker than 8 cm are rare. The vein mineralogy is characterized by quartz, carbonates, fluorite, garnet, sphene, chlorite, cassiterite and other opaque minerals. The distribution of the cassiterite within the veins is erratic, i.e. one part of the vein may return an assay of 1000 ppm while the same vein 3" away may contain as much as 1.5% Sn (Table 1). The grade of mineralization is difficult to decipher because it is dependent on many variables. However, to give an estimate of the Sn content the analytical results on a few selected samples are given in Table 1.

All the Sn-bearing veins studied are enriched in F together with other elements. The details on the metallogenetic elemental associations are being studied. The Sn veins do not favour any one particular type of host rock, however, in every case they have a diagnostic alteration halo. The alteration halo is zoned and in every case the same number of zones are present. Based on a study of more than 100 thin and polished sections it is concluded that the alteration haloes attending the veins are an infallible guide to Sn mineralization. The alteration feature alone may be of considerable use in regional exploration programs.

A report describing the style, wall rock alteration and metallogenetic setting of Sn mineralization is being prepared.

Table 1

Partial analytical data Pearl Lake area - Sn mineralization

A	B	C	D	E	Sn	F	Bi	Cu	Zn
							(in ppm)		
9.0"	3 - 484'6"	1.5"	20"	47°	1450	2560	32	274	300
6.5"	3 - 423'	0.5"	48"	30°	1500	2040	--	5200	1000
11.0"	5 - 478'	2.0"	13"	10°	5400	10060	140	15600	7000
18.0"	5 - 485'	2.5"	26"	39°	3400	7600	60	5200	980
Variation of Sn within the same vein									
1.0"	5 - 442	0.5"	2"	52°	420	--	--	--	--
1.0"	5 - 442	0.5"	2"	52°	1053	--	--	--	--
1.0"	5 - 442	0.5"	2"	52°	15600	--	--	--	--

A = Sample size

B = DDH No. and depth

C = Width of the vein

D = Width of the alteration halo

E = Angle between the core axis and the vein

-- = Not determined

METASOMATIC - HYDROTHERMAL DEPOSITS OF THE NEW ROSS AREA, NOVA SCOTIA

G. A. O'Reilly

INTRODUCTION

Many occurrences of Mo, Sn, W, Cu, F, Mn, and U have been reported associated with the South Mountain batholith in the New Ross-Mahone Bay area of southwestern Nova Scotia. Little published information exists on these occurrences although considerable work has been carried out in the past, both by exploration companies and universities. Figure 1 displays the geology of the study area and shows the occurrences which were located and sampled. Some occurrences were chosen for further detailed mapping and sampling to include all types of deposits found within the area. Emphasis was given to geological setting, distribution of mineralized veins, types and styles of mineralization and causes and conditions of ore deposition.

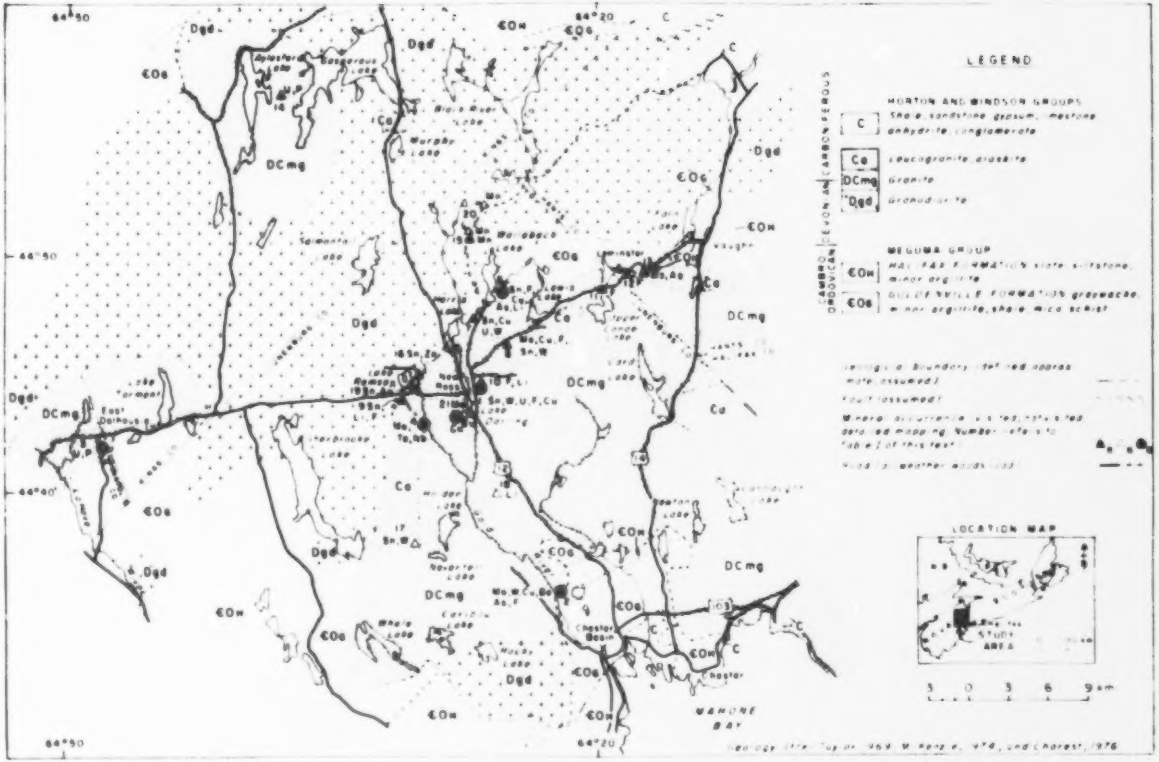
GENERAL GEOLOGY

The geology of the study area is described in detail by Taylor (1969) and McKenzie (1974). The oldest rock exposed in the area is the Cambro-Ordovician Meguma Group which consists of the Goldenville Formation and the conformably overlying Halifax Formation. Elsewhere in southwestern Nova Scotia the Meguma Group is overlain conformably, from oldest to youngest, by the White Rock, Kentville, New Canaan and Torbrook Formations, which range up to Lower Devonian in age. These rocks have been termed the Meguma platform and include deep water turbidites and alkaline volcanics shoaling upwards into shallow water environment slates, quartzites and minor limestones.

Rocks of the Meguma platform have been regionally metamorphosed and deformed into northeast-southwest trending folds by the Lower Devonian Acadian Orogeny. Within the study area, the regional metamorphic grade does not exceed the chlorite grade, but an increase in metamorphism up to sillimanite grade occurs to the southwest.

Intrusive into the Meguma platform is the South Mountain batholith and related plutons which consist of the sequence, from oldest to youngest, biotite granodiorite, biotite granite (adamellite), biotite-muscovite granite (adamellite), leucogranite (leucoadamellite), aplite-alaskite dykes and minor bodies. McKenzie (1974) has mapped and studied the petrology of the central part of the batholith and has proposed a model of in situ fractional crystallization of a calc-alkalic magma with some contamination of this magma by sialic rocks, probably the Meguma Group sediments into which it intruded. This contamination has resulted in a peraluminous corundum normative nature in the more differentiated phases.

Charest (1976) has described the petrology of one of the differentiated two mica granite complexes of the South Mountain batholith, found centred in the New Ross area. This complex, called the New Ross-Vaughn complex, has associated late stage pegmatite and pneumatolitic occurrences of Sn, W, Mo, Cu, U, Li and F.


LEGEND
HORTON AND WINDSOR GROUPS
C Shale, sandstone, gypsum, limestone, anhydrite, conglomerate
CARBONIFEROUS
DEVONIAN
Ca Leucogranite, alaskite
DCmg Granite
Dgd Granodiorite
CAMBRO-ORDOVICIAN
MEGUMA GROUP
€Oh HALIFAX FORMATION slate, siltstone, minor argillite
€Og GOLDENVILLE FORMATION greywacke, minor argillite, shale, mica schist
Geological boundary (defined, approximate, assumed)
Fault (assumed)
Mineral occurrence (visited, not visited, detailed mapping) Number refers to Table I of this text
Road (all weather, woods road)
LOCATION MAP
STUDY AREA
3 0 3 6 9 km
MAHONE BAY
Chester Basin
Chester
New Ross
East Dalhousie
103
12
14
64°30
64°20
44°50
44°40'

Geology after Taylor, 1969, MacKenzie, 1974, and Charest, 1976

Figure 1. Geology and mineral occurrences of the New Ross-Mahone Bay area.

The age of the South Mountain batholith is well established both radiometrically and paleontologically. The granites obviously intruded the fossiliferous Lower Devonian Torbrook Formation and are overlain nonconformably by Lower Carboniferous Horton Group sediments. Radiometric age dates by various labs indicate a range of ages from 410 Ma for the older biotite granodiorite to 350 Ma for the more felsic alaskite dykes and minor bodies. The dates indicate a general age of intrusion of the South Mountain batholith of 370 Ma i.e. an Upper Devonian age.

Sediments of the Meguma platform and the phases of the South Mountain batholith are overlain nonconformably by clastic sediments and carbonates of the Horton and Windsor Groups.

SUMMARY OF FIELD WORK

Within the study area (Figure 1) sixteen of twenty-one occurrences were located and sampled. Table 1 lists the occurrences, types of occurrences and elemental associations. Six were chosen for detailed mapping and sampling. An effort was made to include at least one example of each type of occurrence observed and to provide detailed information on the more interesting showings and those with most potential. Two of the larger prospects, Turner Tin and Walker Moly, were not examined in detail as Farley (1978) has completed a masters thesis on these occurrences so further mapping would be repetitious. A summary of Farley's work will be used. Following is a short summary of the occurrences mapped in detail:

1. Morleys Pegmatite:

An area along Mill Brook was plane tabled at 1" to 100'. Outcrops mapped by Campbell (1940) as pegmatite may in fact be metasomatized brecciated granite which can be seen to grade into unaltered porphyritic biotite-muscovite granite. A jasper breccia dyke is believed associated with this brecciation. Pegmatite associated with a pink medium grained muscovite granite is exposed in the area, but although it is reported to contain cassiterite and radioactive minerals none were observed in outcrop or in the dumps. The brecciation and associated hematization is believed to post date intrusion of pegmatite and associated muscovite granite evidenced in one outcrop in which the brecciation was observed in both the coarse grained biotite-muscovite granite and pink medium grained muscovite granite.

2. Long Lake Mo, W, Cu:

Stripping and drilling carried out in the mid-late 1960's have uncovered a well developed greisen zone and pegmatite and quartz veins on the contact of the batholith with Meguma Group hornfels. An area around the occurrence (approximately 2 square miles) was mapped at 1:10,000 with outcrops of exposed greisen plane tabled at 1" to 10'. Most attention by exploration companies in the past was paid to Mo and Cu mineralization associated with pegmatite and quartz veins. Very little attention was paid to the greisens and their potential for W, Sn, Be, and Mo although highly greisenized fractures and vugs containing significant scheelite, wolframite and beryl were observed.

Table 1. Occurrences of the New Ross-Mahone Bay area.

No.*	Occurrence Name	Type of Mineralization	Elemental Association
1	Morleys Pegmatite	Pegmatite dykes & jasper breccia	Sn, F, radioactive minerals
2	Long Lake	Pegmatite dykes & greisen cupola	Mo, W, Cu, Be, F
3	East Dalhousie	Metasomatized granite	U, F
4	Keddy Prospect	Pegmatite dykes & associated greisen	Mo, Ta, Nb
5	Grassy Brook or Lake Wallaback	Pegmatite with associated greisen and greisenized granite	Sn, F, Cu
6	Lake Darling (A)	Mineralized greisen associated with small pegmatite vein	Cu
7	Turner Deposit	Greisen and quartz greisen veins	Sn, Cu, W
8	Walker or New Russel Deposit	Pegmatite dyke, lesser greisen	Mo, Cu, F, Sn, W
9	Reeves Pit	Pegmatite dyke	Sn, Li
10	Mill Brook	Pegmatite dyke	F, Li
11	Canoe Lake	Fracture fillings in altered porphyritic granite	F
12	Leminster	Fracture fillings in altered porphyritic granite	F
13	Swinimar Occurrence	Quartz veins in Meguma Group hornfels	Mo
14	Gaspereaux Lake	Metasomatized granite	U, F
15	Cain Mine	Mineralized lenses possibly fault controlled, intruding and altering biotite granodiorite	Mn
16	Lake Ramsay (A)		Sn, Zn locations found but occurrences no longer exposed.
17	Nevertell Lake	Pegmatite dyke intruding granite	Sn, W
18	Seffernsville	Quartz, pegmatite dykes intruding biotite muscovite granite	Li
19	Lake Ramsay (B)	Mineralized veins intruding granite	Sn, Au
20	Dean and Chapter Mine	Mineralized lenses possibly fault controlled, intruding and altering biotite granodiorite	Mn
21	Lake Darling (B)	Pegmatite dyke intruding granite	Mo

*Refer to Figure 1 for locations.

Note: Occurrences 1 to 16 visited.
Occurrences 17 to 21 not visited.

3. East Dalhousie U, P:

An area approximately 3 square miles around a recently discovered uranium occurrence in the East Dalhousie area was mapped at 1" to 1320'. Preliminary observations suggest the deposit is metasomatic in origin and overprints all original igneous textures in its porphyritic biotite-muscovite granite host rock.

4. Keddy Prospect:

Although interesting values of Mo have been reported from an aplite associated with large pegmatite dykes in this trenched and pitted prospect, the mineralization is not obvious in the immediate outcrops or dumps. Field observations suggest the aplite, as described, may be greisen possibly with potential for Sn and W. The prospect consists of a large pitted pegmatite dyke to the south, a central pitted and trenched greisen, and a small test pit in pegmatite to the north. A pre-existing map of the occurrence by Cameron (1950) at 1" to 200' was used as a base for mapping.

5. Grassy Brook or Lake Wallaback Sn:

Although the occurrence is small in size, a large outcrop has been stripped showing the relationship between metasomatized granite, greisen, pegmatite and Meguma Group country rock. This outcrop and the immediate surroundings were plane tabled at 1" to 10'. Outcrops in the area were mapped at 1:10,000.

Douglas and Campbell (1942) and Mulligan (1975) have reported interesting Sn values from greisenized granite found associated with a pegmatite intrusion exposed by stripping.

6. Lake Darling Cu:

A small occurrence of Cu in a greisen adjacent to north trending quartz pegmatite veins was mapped at 1" to 10'. Although the altered zone is very small (<3' wide), in the occurrence the transition from metasomatized granite-greisen-pegmatite-quartz is obvious.

At present, literature research and petrography of samples is being carried out. Major and trace element analyses, fluid inclusion and X-ray studies will follow. Final report is anticipated in the spring of 1980.

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METALLOGENIC STUDIES, SOUTHEASTERN CAPE BRETON ISLAND

A. S. Macdonald

INTRODUCTION

Field work was started in the summer of 1979 in the Gabarus - Mira - Point Michaud region of Cape Breton Island (Figure 1) as part of a continuing project to map, describe and characterize the various occurrences of base-metal mineralization in southeastern Cape Breton Island. While all occurrences in the region were examined and sampled, efforts were concentrated mainly within the five areas shown on Figure 1: Blue Mountain, Gabarus Bay, Stirling, Point Michaud, and Salmon River. In each of these areas, except Salmon River, the occurrences themselves and the surrounding country rocks were mapped on scales of 1:4800 and/or 1:15840, and all recently available diamond-drill core was logged. At Salmon River, field work was limited to logging 14 drill cores from one section across the west ore zone which was brought into production in 1979. The mineral occurrences and their host rocks were extensively sampled for petrographic, ore microscopic and geochemical studies which are presently in progress.

These data are intended to define the various types of base-metal mineralization present, and their distribution in space and time in relation to each of the six main sedimentary, volcanic and plutonic units generalized in Figure 1. Hopefully such information will contribute to the understanding of the metallogenic evolution of the region.

A complete report of this project and its findings will be published at a later date.

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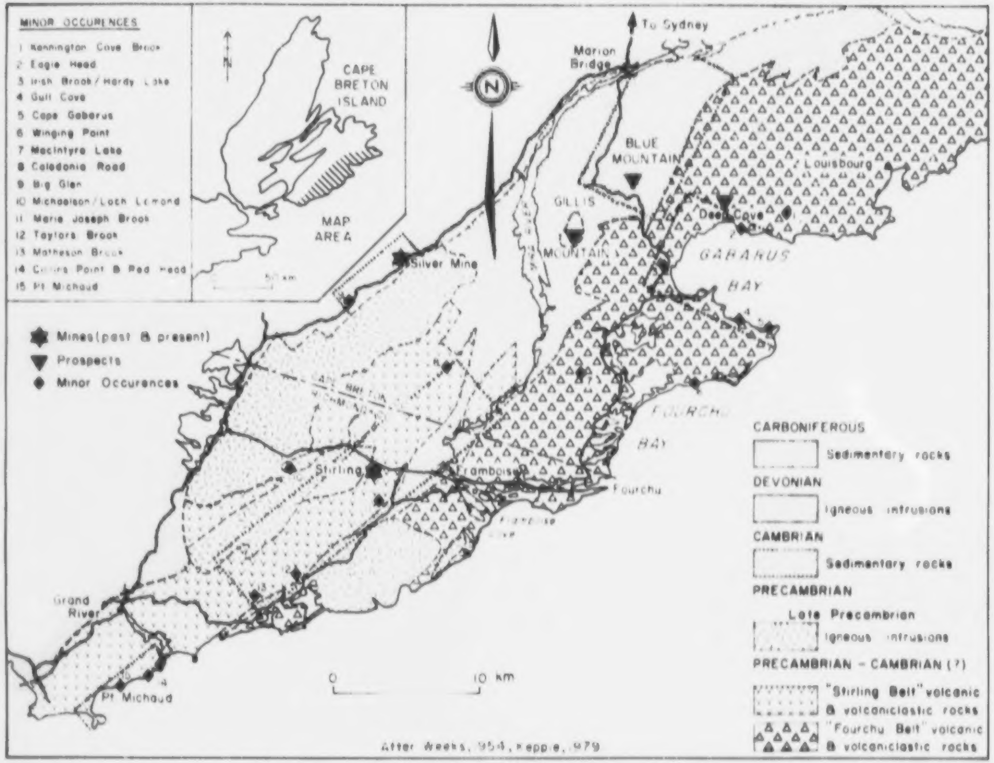

After Weeks, 1954, Keppie, 1979

Figure 1. Generalized geological map showing main areas of study and locations of metallic metal occurrences.

BLUE MOUNTAIN AREA

A. S. Macdonald and P. Scott*

The French Road-Blue Mountain polymetallic mineral prospect is located 1-3 km north of the Sydney to Gabarus highway in Cape Breton County, Cape Breton Island (Figure 1, previous paper, Metallogenic Studies). Mineralization there occurs as replacements, disseminations and veinlets closely associated with calc-silicate felses and knotted/nodular calc-silicate hornfelses, presumed to be contact metamorphosed and/or metasomatized equivalents of middle Cambrian strata. Most recent mineral exploration was conducted in 1976-77 by St. Joseph Exploration Ltd. which did extensive geochemical soil-sampling, geophysical surveys (magnetic, EM and IP), and 4750 ft. of diamond drilling (McCulloch, 1977; Sangster, 1977). A brief mineralogical description of some of the ore and calc-silicate host rocks has also been published by NSDME (Chatterjee, 1976).

For this study, geological mapping was done on two scales (background mapping at 1:15840 and more detailed mapping at 1:4800) and all available core was logged.

Background mapping covered an approximately 45 km^2 block of middle to upper Cambrian rocks south of the Mira River, bound to the south and west by Highway 327 and to the east by lower Cambrian sedimentary rocks and late Precambrian metavolcanic and volcaniclastic rocks. The purpose of this mapping was (a) to determine the lithology, stratigraphy and structure of the Cambrian strata outside of the contact metamorphic aureole, and (b) to define the limits of the aureole itself.

The surrounding rocks are predominantly dark blue-grey shales with sparse calcareous nodules, minor siltstones and grey sandstones, and rare thin limestone beds. A weak slaty cleavage is commonly developed in the shales which is apparently axial planar to upright asymmetric minor folds verging westwards and plunging at low angles to the north-northeast or northeast. No igneous rocks, were recognized within these rocks, and the only other materials noted were a few quartz veins and local trace disseminations of pyrite. The aureole was mapped showing it, subject to the limited number of outcrops, to be a northeasterly trending, crudely elliptical area, approximately 1 by 3 km.

Detailed mapping within the aureole showed the predominant rock types to be uniform hornfels and knotted/nodular calc-silicate hornfels, i.e. hornfels containing up to 25-30% of zoned calc-silicate knots or nodules, averaging 3-5 cm in diameter. Locally, where sufficiently abundant, these knots have coalesced to produce amoeboid, convoluted and banded calc-silicate bodies up to 20 cm thick. Rare 1-2 m thick layers of calc-silicate fels (skarn?), which host the highest concentrations of sulphides, also occur within the knotted hornfels apparently conformable with relict bedding. Medium grained quartz-biotite fels layers within the hornfelses, probably represent sandstone beds. Towards the periphery of the aureole the hornfelses give way to spotted hornfels and meta-argillite within which bedding and cleavage

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become more obvious. Relict bedding and/or cleavage can be recognized at numerous localities within the aureole and interpretation of the distribution and geometry of these S-planes indicates that the structure within the aureole consists of repetitive upright, asymmetric folds verging toward the west. The only igneous rock recognized within the aureole was a single outcrop of weathered feldspar porphyry possibly representative of dacite porphyry sheets observed in several of the drill cores. Quartz-calcite veins commonly form local swarms and stockworks within the hornfelses.

Logging of the core from a total of 13 holes drilled by St. Joseph Exploration Ltd. was also done in order to compare surface and subsurface units, and to describe and sample the mineralization and associated calc-silicate rocks. The mineralization observed in the core appears to occur in several associations:

(a) sulfarsenide/arsenide (?) ± bismuthinite ± molybdenite ± pyrrhotite ± chalcopyrite as disseminations and patchy replacements within calc-silicate fels layers.

(b) pyrrhotite ± chalcopyrite as disseminations within zoned calc-silicate knots.

(c) sphalerite ± galena in quartz-calcite veinlets.

(d) pyrrhotite ± pyrite concentrations along bedding and/or cleavage planes in meta-argillites.

Anomalously high silver and tin values have also been reported from soils and from assays of drilling sludges (McCulloch, 1977). The silver reportedly occurs as inclusions of argentite within the sulfarsenide/aresenide mineral (A. K. Chaterjee, personal communication, 1979).

Although the intrusive source for the contact metamorphism and mineralization at Blue Mountain cannot be unequivocally demonstrated, the polymetallic mineralization resembles, in its elemental association, that found at Deep Cove, 7 km to the east-southeast, and may therefore also be of Devonian age (assuming the mineralization to be essentially the same age as the associated igneous intrusion). The origin of the calc-silicate layers and knots with which the mineralization is most closely associated is not clear, nor has the relative importance of contact metamorphism vs. metasomatism in their transformation been established. The parental rocks for these could have been impure calcareous (sideritic?) bands and nodules.

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GABARUS BAY AREA

A. S. Macdonald, P. Scott*, E. A. White and D. L. Smeltzer**

This area was selected for study because it extends west and south from the Deep Cove polymetallic mineral prospect and also includes a number of small iron-copper occurrences (Figure 1, Metallogenic Studies). The Deep Cove prospect is located on the northern side of Gabarus Bay approximately 30 km south-southeast of Sydney. Mineralization there is associated with a granitic stock of Devonian age, and has been described as having porphyry Cu-Mo affinities (Kirkham and Soregaroli, 1975). The mineralization occurs as disseminations within altered granite, and in quartz veins and shear zones cutting both granite and hornfelsed volcanic and volcaniclastic rocks of the Fourchu Group.

Most recent exploration activity was by Louisbourg Mines Ltd. who diamond drilled ten holes totalling approximately 4250 ft. and excavated several trenches during 1979. This followed an investigation, under option, by St. Joseph Exploration Ltd. in 1977, involving an IP geophysical survey and 5 diamond-drill holes totalling 1790 ft. (Sangster, 1977). Of the other occurrences only that at Irish Brook has been the subject of any intensive investigation (Leslie, 1968).

For the present study, geological mapping of the west and south sides of Gabarus Bay was done on a scale of 1:4800, most of this mapping being of coastal sections. The purposes of this mapping were (a) subdivision of the Fourchu Group, (b) determination of the nature and setting of mineral occurrences within these rocks, and (c) comparison with hornfelsed (but presumably laterally equivalent) units of the Fourchu Group in the vicinity of Deep Cove on the north side of Gabarus Bay.

The exposed sequence is dominated by very thick units of essentially massive, intermediate and felsic lapilli tuffs and agglomerate which apparently alternate with thinner sequences of andesitic, and lesser dacitic lava flows. Rare thin-bedded tuffs and tuffaceous sediments displaying graded-bedding, and scour structures, and thin flow-banded rhyolites also occur locally (e.g. the northwestern side of the Bay). All of these rocks are intruded by two swarms of igneous sheets, porphyritic felsites and basalts(?), which generally follow the well-developed metamorphic foliation of the host rocks. Whereas the basalt (?) sheets exhibit the same metamorphic foliation as the host rocks, the felsites are commonly strongly fractured and veined by quartz, epidote and hematite.

At Gull Cove near the southeastern end of Gabarus Bay, a subvolcanic stock (about 1 km wide) of quartz-feldspar porphyry has intruded the Fourchu Group. As the porphyry is itself weakly foliated and apparently cut by foliated basalt(?) sheets, it is believed to be of the same general age as the country rocks, rather than of Devonian age like the Deep Cove stock. Within the stock occur occasional narrow

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bands of pink K-feldspar alteration, apparently fracture-controlled, but no sulphides were observed anywhere within the body.

Two other types of intrusions were observed within a sequence of intermediate tuffs between the west side of Gabarus Bay and Hardy Lake: older foliated andesite/diorite porphyry plugs(?), and a younger fresh gabbro sheet. Two suites of younger unfoliated dykes also cross-cut the main structural trend: east-northeasterly to southeasterly trending basalt dykes, and east-northeasterly to northeasterly trending quartz-feldspar porphyry dykes.

At four localities around the northwestern corner of Gabarus Bay occur very coarse sedimentary breccias (comprised largely of angular blocks of Fourchu volcanic and volcaniclastic rocks cemented by lithic sandstone), with minor interbedded brown lithic sandstones, which unconformably overlie the Fourchu Group. These are tentatively assigned to the Grantmire Formation.

Several minor occurrences of pyrite ± minor chalcopyrite occur in Fourchu rocks around the west and south sides of Gabarus Bay. Most appear to be fracture- and shear-controlled disseminations of very restricted distribution. A few also occur in irregular quartz-hematite veins which are commonly developed in the porphyritic felsite sheets cutting the Fourchu volcanic rocks. Sparse large pyrite cubes are widely developed in many outcrops of tuff, but these are presumed to be of metamorphic origin. Abundant float blocks of heavily pyritized felsic tuff were noted at the base of the till bank between Gull Cove and Cape Gabarus.

Core from the ten holes drilled by Louisbourg Mines Ltd. at Deep Cove in 1979 was logged as part of this study. The holes were drilled in an elongate northwest-southeast pattern across the granitic stock. The core shows a complex sheeted relationship between the granite and the intruded Fourchu rocks (mainly dacitic flows and tuffs, themselves cut by basaltic sheets). Alteration consists of extensive weak K-feldspathization of the granite within which occur frequent narrow zones of intensely altered granite and greisen. The latter occur most frequently within the upper 250 ft. of the holes, but more restricted amounts occur to depths of at least 700 ft.

The most obvious modes/associations of mineralization included:

a) molybdenite ± pyrite ± chalcopyrite in quartz veins and on fracture surfaces cutting both granitic and volcanic rocks.

b) pyrite ± molybdenite ± chalcopyrite as sparse disseminations within altered granite.

c) pyrite ± chalcopyrite ± sphalerite ± bismuthinite associated with greisen zones as disseminations and in quartz-calcite veinlets.

d) pyrite ± molybdenite disseminations in altered breccia/shear zones cutting the volcanic rocks.

Mineralization at Deep Cove apparently does show "porphyry-affinities" (Kirkham and Soregaroli, 1975) in its association with intense alteration, veining and brecciation of both the granitic stock and the volcanic country rocks. The small occurrences within volcanic rocks around the west and south sides of Gabarus Bay appear to be minor epigenetic Fe-Cu showings of, as yet, unknown affinity and age.

Correlation of volcanic stratigraphy from north to south across Gabarus Bay is difficult, even though similar components can be recognized. This is perhaps because of one or more of the following factors:

a) effects of contact metamorphism overprinting the sequence in the Deep Cove area;

b) rapid lithological changes along strike as might be anticipated in volcanic terrane;

c) effects of common east-southeasterly to southeasterly trending faults having caused offsets and/or changes in level.

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STIRLING AREA

A. S. Macdonald and P. Scott*

Detailed mapping by Cominco Ltd. (Roscoe, 1975; Hunter and Anderson, 1975) in the vicinity of the abandoned Mindamar zinc-lead-copper mine, at Stirling (Figure 1, Metallogenic Studies) has resulted in a subdivision of the volcanic, volcaniclastic and sedimentary country rocks there which may be applicable to the whole belt of rocks mapped as Bourinot Group by Weeks (1954). Recently these rocks have been re-assigned to the Precambrian and equated with the Fourchu Group (Smith, 1978; Keppie, 1979). The ore deposit at Stirling has been studied by Miller (1979) who has demonstrated that it possesses many features characteristic of volcanic-exhalative base-metal deposits, confirming the classification by Poole (1974) of this deposit as volcanogenic.

The purposes of this study were: (1) to attempt subdivisions of the rocks farther to the northeast and southwest along strike from the Stirling mine area; (2) to map and sample the several pyritic occurrences which occur in the same general area (Caledonia Road, Marie Joseph Brook, Taylors Brook, Matheson Brook, and Michaelson/Loch Lomond occurrences); and (3) to provide data for comparison of these rocks and their associated mineralization with those of the Fourchu Group.

Mapping on a scale of 1:15840 was done of two narrow blocks, 2-3 km wide, northeast and southwest of the mine area to give a total strike coverage (in combination with the Cominco map) of about 20 km (Figure 1, Metallogenic Studies). In addition, more detailed mapping on a scale of 1:4800, was also done of the Caledonia Road occurrence 9 km northeast of Stirling, and of the Michaelson/Loch Lomond occurrence 6 km west of Stirling. Core was also logged from four holes diamond drilled by Cominco Ltd. in 1978 near the Stirling mine.

Volcanic units within the mapped blocks include distinctive quartz-feldspar rhyolite porphyry (and more-or-less schistose/tuffaceous (?) equivalents), minor dacite (?) and more common andesite. Associated volcaniclastic rocks include a variety of intermediate to felsic lapilli tuffs and fine grained tuffs which are locally interbedded with (and not always distinguishable from) their epiclastic equivalents. In a general way there appears to be a decrease in the ratio of volcanic/volcaniclastic rocks from southwest to northeast along strike. Two other distinctive units which occur in close association with the ore at Stirling (Miller, 1979) can also be recognized along strike: (2) thinly interbedded cherts, siltstones, sandstones and fine tuffs which locally contain stratiform pyritic disseminations; and (b) orange weathered quartz-carbonate schist (either an alteration product or chemical precipitate prior to regional metamorphism?). All of these rocks have commonly been intruded by basaltic sheets and dykes, and locally by granitic dykes. However, neither the relative nor absolute ages of these intrusive events are known, although it could be assumed that the granitic event is related to intrusion of the Loch Lomond, Marie Joseph and Capelin Cove plutons.

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The structure of the volcanic-volcanoclastic rocks is not well known. However, relatively large scale folding can be recognized in clearly bedded rocks, e.g. in the Caledonia Road area and in the Point Michaud-Red Head coastal section (see the next paper of this report, Point Michaud Area). The commonly developed metamorphic foliations, both cleavage and schistosity, are approximately axial planar to these fold structures. It is still not known whether or not there has been any repetition of major units due to large-scale folding. Metamorphic grade, as determined from the more schistose units, does not appear to have exceeded lower greenschist facies, although at the Michaelson/Loch Lomond occurrence, 6 km west of Stirling, there has been contact metamorphic overprinting to at least hornblende-hornfels facies by the Loch Lomond and/or Marie Joseph plutons.

Orange weathered quartz-carbonate schist lenses were mapped at several localities both northeast and southwest of Stirling. However, no definite pattern is evident from their distribution, except perhaps that they tend to occur within or adjacent to rhyolite porphyry flows southwest of Stirling, and also near contacts between felsic lapilli tuffs and andesites, in the general vicinity of occurrences of thin-bedded pyritic cherts, siltstones and tuffs.

Pyritic mineralization outside of the Stirling mine area appears to be of several types:

(a) massive pyrite lenses/pods occurring at contacts between rhyolite porphyry and bedded tuffs (e.g. Marie Joseph Brook and possibly Taylors Brook);

(b) disseminated stratiform pyrite in thin bedded cherts, siltstones, tuffs (e.g. Caledonia Road, see also Collins Point and Red Head in the next paper of this report, Point Michaud Area).

(c) pyrite ± sphalerite dissemination(s) in contact metamorphosed volcanic-volcaniclastic rocks (Michaelson/Loch Lomond occurrence). Note the possibility that this occurrence represents contact metamorphosed pre-existing mineralization rather than contact metasomatic neomineralization.

In 1978, Cominco Ltd. drilled four holes, one east and three northeast of Stirling mine. No massive sulphide mineralization was found, but essentially stratiform pyritic disseminations were intersected in thinly bedded siltstones, minor cherts and tuffaceous sandstones in contact with rhyolite porphyry flows and flow breccias (?), minor aphanitic rhyolite and calcareous intermediate tuffs, all frequently cut by basaltic sheets ranging in thickness from a few centimetres up to 20 m. The rhyolite porphyries display varied intensities of shearing and alteration and some of the more intensely affected could not be distinguished with confidence from quartz-feldspar crystal tuffs. These foliated and altered porphyries/crystal tuffs themselves contain local concentrations of pyrite as disseminations, fracture fillings, and rare sulphide clasts(?).

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POINT MICHAUD AREA

K. A. White and D. L. Smeltzer*

This area comprises the coastal section between Point Michaud and Red Head, Richmond County, Cape Breton (Figure 1, Metallogenic Studies). In total approximately 7 km of coastline were mapped at a scale of 1:4800.

This section was chosen because it lies within the same volcanic-sedimentary belt as, and on approximate strike with, the volcanogenic Zn-Pb-Cu deposit at Stirling (Mindamar Mine). Strata-bound pyritic mineralization and quartz-carbonate alteration are present along the coastal section; at Stirling they are closely related to the ore deposit (Miller, 1979).

Along the northeastern part of the section toward Red Head, the mapped sequence consists of metavolcanic rocks (basalt and basaltic andesite) apparently conformably overlain by meta-pyroclastic rocks (andesitic tuffs and lapilli tuffs) and minor andesite. Conformably overlying these are thinly interbedded siltstones, cherts and tuffs or tuffaceous sandstones. Polymictic cobble conglomerate, possibly of the Lower Carboniferous Horton Group, unconformably overlies the volcanic rocks at one locality.

The sequence of the rocks exposed on Point Michaud itself consists of andesitic tuffs apparently overlain by andesite and rhyolite.

All of these rocks have been subjected to lower greenschist facies metamorphism as evidenced by the common occurrence of chlorite, epidote and sericite.

Dykes and sheets of basalt, felsite, granite and quartz-feldspar porphyry have intruded all pre-Horton(?) rocks within the study area.

A large-scale upright anticlinal fold, affecting interbedded siltstones, cherts, and fine tuffs near Collins Point, has a fold axis bearing 055° and plunging 30°NE. A weak slaty cleavage, also present in these rocks, has an average orientation of 115°/90° which is not obviously axial planar to the fold. However, the average orientation of schistosity in the adjacent tuff and volcanic units is 080°/70° NW, which is more closely axial planar to the folding.

Faulting is common, with one set striking east-northeast approximately parallel to the general strike of the country rocks, and another crosscutting set trending north-northeast to north-northwest. The main joint directions are 128° and 185°, both with a near vertical dip. Veins of calcite, quartz and epidote are common in the basalts and tuffs. The average strike and dip of the veins is approximately 085°/80°N.

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Bands of white to yellow crystalline quartz carbonate alteration several metres thick are found in at least two locations, approximately 0.6 km apart, near Collins Point. One strikes 085° and the other at 150°, generally subparallel to layering in the adjacent siltstones, cherts and tuffs, although some contacts are gradationally crosscutting indicating replacement of the country rocks.

Pyrite is locally abundant within the interbedded siltstone-chert-tuff as diffuse to stratiform disseminations. Local sparse disseminations also occur within the tuffs and basalts.

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SALMON RIVER LEAD DEPOSIT

P. Scott*

The Salmon River lead deposit is located at Silver mine, approximately 30 km south of Sydney, Cape Breton Island (Figure 1, Metallogenic Studies). Access to the mine site by road is from Sydney via Marion Bridge. The mine, operated by Yava Mines Ltd., was officially opened in July 1979. Figures regarding ore grades and tonnages have been published elsewhere (Northern Miner, 1977; Patterson, 1979).

Underground development was at an initial stage during the summer of 1979 therefore field work was restricted to logging the available core along a single section (33W) across the west ore zone. A total of 14 holes had been drilled along this line, 5 by Phelps Dodge Corporation, and 9 by Yava Mines Ltd. Of the 5 earlier holes, only 2 complete and 2 incomplete ones were available. A total of 3320 ft. were logged. The core was extensively sampled for geochemical and petrological study. Samples for geochemical analyses were taken at 3 ft. intervals in the ore zone, and 10 ft. intervals outside. This gave a total of 100 samples within the ore zone and 300 outside. Samples for petrological study were selected from each lithological unit, and numerous additional samples were taken randomly at points of interest within the ore zone.

The objectives of this study are:

(a) petrological investigation of the host rocks and sulphides;

(b) geochemical characterization of the mineralization using silver, antimony, copper and zinc values in galena concentrates;

(c) investigation of the nature and the distribution of the silver-bearing phase reported from the deposit;

(d) definition of any mineralogical or geochemical zoning patterns within the deposit;

(e) comparison of this deposit, with other sandstone-hosted lead deposits in Scandinavia, France and Africa.

The results of this study will be submitted as a M.Sc. thesis at Acadia University.

The basement in the Salmon River area, is a rhyolite or microgranite considered to be part of the Loch Lomond pluton (Weeks, 1954; Keppie, 1979), which has been dated at 548 ± 18 Ma (Cormier, 1972; Keppie and Smith, 1978). Beneath the mine it consists of a pinkish to reddish-brown rhyolite, which is unconformably overlain by Windsor and Pennsylvanian sedimentary rocks, the former reaching a maximum thickness of 150 ft. and the latter reaching a thickness of 1500-2000 ft. towards the centre of the basin.

The Windsor sequence starts with a rhyolite breccia, arkose and siltstone. These are overlain by an interbedded sequence of grey and brown siltstones and shales, thin dolomites and evaporites, followed by a sequence of maroon and green siltstones, with thin dolomite interbeds.

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In places the Windsor is not preserved and the Pennsylvanian oversteps onto the rhyolitic basement. In most holes along the section studied the top of the Windsor is marked by a limestone breccia, consisting of angular to subrounded limestone fragments in a green clay matrix. This is interpreted by Moore (personal communication, 1979) as a solution-collapse breccia.

The Pennsylvanian sequence unconformably overlies the Windsor, and consists mainly of sandstones, with minor grits, conglomerates, breccias, siltstones and very thin coals. A notable feature of the sandstones is that they are very poorly indurated. Other minor rock types present include dolomite-pebble conglomerates, sandstone-shale breccias, and sandstone-coal breccias. Correlation, even of thick units, between drillholes is difficult. Thus a flood plain environment is tentatively suggested for the deposition of the Pennsylvanian strata.

The ore deposit occurs in the basal part of the Pennsylvanian, and forms three distinct zones along strike, on the southeastern edge of the Salmon River basin (Patterson, 1979). These zones occur over paleochannels which exist in the underlying basement. The west ore zone has a strike length of approximately 1500 ft., and ore grade mineralization extends from the surface downdip for a length of about 2500 ft.

Thin-section studies have classified the host sandstones as feldspathic litharenites and litharenites (Folk, 1968). The fragments in the coarser beds are of siltstone and mudstone, quartz, feldspar, dolomite and volcanic and metamorphic rocks. Staining techniques have shown that iron-rich dolomite occurs as a local replacement cement. The amount ranges from tiny patches, to large concretionary nodules (examples up to 4 feet in diameter can be observed in the mine workings).

Preliminary studies of polished mounts and thin sections have shown that galena and pyrite are the two main sulphides present. Minor amounts of sphalerite and rare chalcopyrite are also present, and a sulphosalt has also been reported to occur (Chatterjee, personal communication, 1979). The sulphides occur as disseminations and concentrations along bedding planes, apparently as infillings of the porosity. The grain size of the galena is very small, approximately 0.01 to 0.1 mm in diameter. Pyrite is usually larger, the maximum size being approximately 10 mm. Pyrite, and to a lesser extent galena, are frequently associated with coal, the pyrite typically occurring as a massive replacement of the coal, with galena, if present, forming a halo around it.

Approximately 100 samples from the ore zone have been crushed and the galenas concentrated using a Superpanner. These galena concentrates are presently being analyzed at Acadia University, by Atomic Absorption Spectrophotometry for Sb, Ag, Cu, Fe, Zn and Pb. Whole rock analyses for Barium, using X-ray fluorescence, are also planned for selected samples. Results of these analyses are not available at this time.

The Salmon River deposit, is similar in many respects to other sandstone-hosted lead deposits described from Laisvall in Sweden (Rickard, et al., 1979), and from L'Argentiene in France (Samana, 1976). All three deposits are characterized by simple ore mineralogy comprising galena, sphalerite and pyrite accompanied by accessory carbonate, barite and fluorite. The mineralization at Laisvall and Salmon River is located above paleochannels in the basement whereas, at L'Argentiene, the mineralization is located above paleoridges as well as paleochannels. In all three deposits the galena occurs as pore fillings and concentrations along bedding planes, apparently closely linked to paleopermeability and porosity, although at L'Argentiene, the situation has been complicated, due to remobilization caused by later faulting.

ACKNOWLEDGMENT

The writer would like to acknowledge the help and cooperation of Dr. J. M. Patterson and Vernon Betts of Yava Mines Ltd., without which this study could not have been undertaken.

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STRUCTURAL STUDIES

J. D. Keppie

The main progress in this project during the year has been the preparation of the new maps of the Province. These are published in three editions: geological, geophysical and mineral deposits. The geological edition includes the geological map at 1:500,000 and the metamorphic and structural maps at 1:1,000,000. The geological map incorporates maps between the inception of mapping in the Province over 100 years ago and the end of 1978. It is accompanied by a cross-section and a legend divided into three columns: southern mainland, northern mainland and Cape Breton Island. The geological map is also available on open file (OFR 405) as three sheets at a scale of 1:250,000. The structural map of Nova Scotia shows the effects of deformation, such as folds, foliations and faults, colour-coded according to their age. The structural elements are superimposed upon pastel-shaded areas colour-coded to show the age of the first deformation. The intensity of deformation, gentle, tight or polyphase, is depicted by different pastel shades. Superimposed deformation is shown by structural elements of one colour upon a shaded area of a different colour. Plutonic rocks are divided into undeformed or deformed and represented by coloured random or oriented dashes, respectively. The metamorphic map was compiled in cooperation with Dr. G. K. Muecke, Geology Department, Dalhousie University. The map portrays only the highest grade of the first regional metamorphism colour-coded according to age and grade. Retrograde and contact metamorphism are omitted. Superimposed regional metamorphism of different ages is only shown where the later metamorphism is of higher grade than the earlier metamorphism.

The geophysical edition of the map includes the Bouguer Gravity Anomaly contours printed upon the geological map, residual total magnetic field contours printed upon the metamorphic map, and seismic data plotted on the structural map. Gravity data were supplied by Gravity and Geodynamics Division, Earth Physics Branch, Department of Energy, Mines and Resources, Ottawa from information in the National Gravity Data Base current to 1978. Magnetic data were provided by P. J. Hood, Geological Survey of Canada and taken from the Magnetic Map of the Atlantic Provinces compiled by D. A. Reveler, Geological Survey of Canada Open File 496, 1977. The seismic data are from Dainty, et al., American Geophysical Monograph 10, p. 349-369.

The mineral deposits edition of the map shows the mineral deposits printed upon the geological map. The mineral deposits were compiled by D. J. Gregory, A. K. Chatterjee and N. A. Lyttle. Also, published at the same time were 1:2,000,000 versions of all of these maps.

Other products of this project include:

(i) a compilation of chemical analyses of igneous rocks from Nova Scotia gleaned from many pre-1978 published and unpublished sources, J. Duncan Keppie and P. K. Smith (compilers).

(ii) Paleozoic volcanic rocks of Nova Scotia, by J. Duncan Keppie and J. Dostal, paper in press.

(iii) The Minas Geofracture by J. Duncan Keppie, paper in preparation.

(iv) The Fisset Brook Formation at Lowland Cove, Cape Breton Island, Nova Scotia, by P. K. Smith and A. S. Macdonald, paper in preparation.

(v) Geology of Cape North area, northern Cape Breton Island, Nova Scotia, by A. S. Macdonald and P. K. Smith, paper in press.

(vi) Petrology of the Late Precambrian Fourchu Group in the Louisbourg area, Cape Breton Island by J. Duncan Keppie, J. Dostal and J. B. Murphy, paper in press.

(vii) a field trip guide to Nova Scotia by J. Duncan Keppie and J. B. Murphy as part of the northern Appalachian Geotraverse, Quebec, New Brunswick-Nova Scotia led by N. Rast, et al., for the 1980 Geological Association of Canada Annual Meeting in Halifax, Nova Scotia.

(viii) a submission to the Canadian Ordovician Correlation Chart for Nova Scotia, J. Duncan Keppie.

Abstracts of these papers appear on succeeding pages.

PALEOZOIC VOLCANIC ROCKS OF NOVA SCOTIA*

J. D. Keppie

and

J. Dostal**

ABSTRACT

Paleozoic volcanic rocks in the Avalon Zone in Nova Scotia are of Early-Middle Cambrian, Late Ordovician-Early Silurian and Middle Devonian-Early Carboniferous ages. In the Meguma Zone only Late Ordovician-Silurian volcanic rocks are present. All of these Paleozoic volcanic rocks are generally bimodal, are transitional between alkalic and tholeiitic and were extruded upon continental crust in an anorogenic or extensional, "within-plate" tectonic setting. This reflects the fact that Paleozoic volcanism occurred early during each cycle of marine incursion and is rarely evident during orogenic episodes.

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* Paper in press; presented at the International Geological Correlation Project Annual Meeting in September, 1979, Blacksburg, Virginia.

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THE MINAS GEOFRACTURE*

J. D. Keppie

ABSTRACT

The Minas Geofracture is defined as the east-west boundary between the Meguma and Avalon Zones in and adjacent to Nova Scotia. It is a deep crustal fault that separates dissimilar Precambrian and Lower Paleozoic rocks. It is inferred to have originated during the Middle Devonian Acadian Orogeny. Prior to that time, the Avalon Zone, from Boston through coastal Maine and southern New Brunswick to near the Magdalen Islands, is interpretated as a southwesterly strike continuation of Cape Breton Island. This palinspastic reconstruction is based upon correlation of Precambrian - Early Devonian lithotectonic and paleogeographic belts. During the Acadian Orogeny 370 - 475 km of dextral movement took place on the Minas Geofracture. Some vertical relief on the Geofracture is indicated by the presence of Mid-Late Devonian molasse only on its northern side. During Early-Late Carboniferous times the Minas Geofracture was generally inactive, however, 375 km of dextral movement took place upon a fault parallel to Chignecto Bay. As a consequence of these dextral movements the Fundy Basin formed as a complex rift where the Appalachians swing through a Z-shaped bend. During the Late Westphalian to Permian Hercynian Orogeny, approximately 165 km of dextral movement is inferred to have taken place on the Minas Geofracture. Finally, during Early Mesozoic times, approximately 75 km of sinistral movement took place on the Minas Geofracture as the Bay of Fundy Rift formed in response to the opening of the Atlantic Ocean.

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*Paper in preparation; presented at the Geological Association of Canada Annual Meeting in Quebec City, 1979.

THE FISSET BROOK FORMATION AT LOWLAND COVE, CAPE BRETON ISLAND, NOVA SCOTIA*

P. K. Smith and A. S. Macdonald

ABSTRACT

At Lowland Cove, the Fisset Brook Formation consists of a sequence of massive porphyritic rhyolite overlain by conglomerate interbedded with sandstone and siltstone, followed by basaltic and andesitic tuff and basaltic and andesitic flows. They lie nonconformably upon a gneissic syenite and granitic rocks, and are unconformably overlain by siltstones and conglomerates of the Horton Group. Spores recovered from the sedimentary rocks in the Fisset Brook Formation tentatively indicate a latest Late Devonian age (D. C. McGregor, written communication, 1979). The geochemistry of the volcanic rocks indicates that they are bimodal and mildly alkalic with some tholeiitic characteristics, extruded in a "within-plate", anorogenic or rift environment. The Fisset Brook Formation at Lowland Cove has been gently folded about a gently northward plunging, upright syncline, and cut by faults. Minor pyrite/chalcopyrite mineralization associated with calcite veins occurs in the basaltic tuff. Traces of malachite occur in fault zones cutting the rhyolites and conglomerates along the shore.

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*Paper in preparation.

GEOLOGY OF CAPE NORTH AREA, NORTHERN CAPE BRETON ISLAND, NOVA SCOTIA*

A. S. Macdonald and P. K. Smith

ABSTRACT

Low- to medium-grade schistose volcanic and sedimentary rocks of the Money Point Group occur along the eastern margin of the area, abutting medium- to high-grade paragneissic rocks of the Cape North Group to the west. The two Groups of metamorphic rocks appear to be essentially conformable with no evidence for any erosional or tectonic break between them. Both groups also appear to have been affected by the same sequence of events. Two episodes of penetrative, coaxial folding can be recognized, followed by a third episode of complex chevron/kink folding. The peak of regional metamorphism was attained synchronously with the second episode of penetrative deformation, and can be defined as having been of intermediate pressure, medium- to high-temperature type. Metamorphic grade increases rapidly toward the west from biotite, through cordierite and staurolite, to kyanite and sillimanite zones. The higher grade zones coincide spatially with a synkinematic lit-par-lit granitoid injection complex which is developed mainly within the gneissic rocks of the Cape North Group, but which also overlaps and complicates the contact with the schistose rocks of the Money Point Group to the east. Older foliated granitic plutons in the area are believed to be late-kinematic products of this metamorphic-anatectic event. Younger, unfoliated granitic plutons which occur adjacent to the Aspy Fault are relatively high-level, crosscutting intrusions. The two penetrative deformations, regional metamorphism, and injection and emplacement of foliated granites are believed to be related orogenic events of Late Precambrian to Early Cambrian age. Later nonpenetrative deformation and emplacement of younger unfoliated granitic plutons are probably Paleozoic in age, perhaps produced during the Acadian Orogeny.

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*Paper in press; presented at the Atlantic Geoscience Society Colloquium on Current Research in the Atlantic Region, 1979.

PETROLOGY OF THE LATE PRECAMBRIAN FOURCHU GROUP IN THE LOUISBOURG AREA, CAPE BRETON ISLAND*

J. D. Keppie, J. Dostal**, and J. B. Murphy***

ABSTRACT

The rocks of the Hadrynian Fourchu Group around Louisbourg consist mainly of pyroclastic rocks such as crystal tuff, ignimbrite, breccia, tuff and ash layers and subaerial and submarine, sodic basalt, andesite, rhyodacite and rhyolite flows. Minor intrusive feeder dykes and sills cut this volcanic pile. Small gabbroic plutons are inferred to be subvolcanic. These rocks were subsequently deformed and subject to greenschist facies metamorphism during the Late Hadrynian Cadomian Orogeny. The major, trace and rare earth element geochemistry of these igneous rocks documents that they have calc-alkaline, island arc affinities erupted on thin continental crust at about 40 to 80 km above a paleo-Benioff zone. An origin by anatexis of the upper mantle and crust followed by fractionation of pyroxene, olivine, spinel and plagioclase is inferred.

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* Paper in press.

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GEOLOGY OF THE NORTHERN ANTIGONISH HIGHLANDS

J. B. Murphy*, J. D. Keppie and A. Hynes*

The Precambrian rocks in the northern Antigonish Highlands have been mapped as the Georgeville Group (Figures 1 and 3). The Georgeville Group has been divided into seven formations (Table 1).

Table 1. Geological history of the northern Antigonish Highlands

AGE		EVENT		
MIDDLE DEVONIAN		ACADIAN OROGENY		
EARLY DEVONIAN		Knoydart Formation		
SILURIAN		Arisaig Group McGillivray Brook Formation		
? LATE ORDOVICIAN		Dunn Point Formation		
		TACONIAN OROGENY		
EARLY ORDOVICIAN	Iron Brook Group	Ferrona Formation	MacDonalds Brook Group	Arbuckle Brook Formation
CAMBRIAN		Little Hollow Formation		
		Black John Formation		Malignant Cove Formation
LATE PRECAMBRIAN		CADOMIAN OROGENY		
	Georgeville Group	South Rights Formation		
		Clydesdale Formation		
		James River Formation		Livingstone Cove Formation
		Maple Ridge Formation		Morar Brook Formation
				Chisholm Brook Formation

Of these, three occur in the coastal strip (Figure 1) and the other four outcrop inland (Figure 2). The lowest unit exposed in the coastal strip is the Chisholm Brook Formation. It consists of interlayered ocean-floor tholeiitic, mafic flows, tuff, marble and mudstone in the west, and mafic flows and tuff pervasively intruded by dykes in the east. The overlying James River Formation is composed of mainly black porcelainous mudstone interbedded with thin siltstone and chert horizons and rare thin limestone and conglomerate beds. Crossbedding, graded bedding and slump structures are present in these beds. The contact between the James River and Chisholm Brook Formations is grad-

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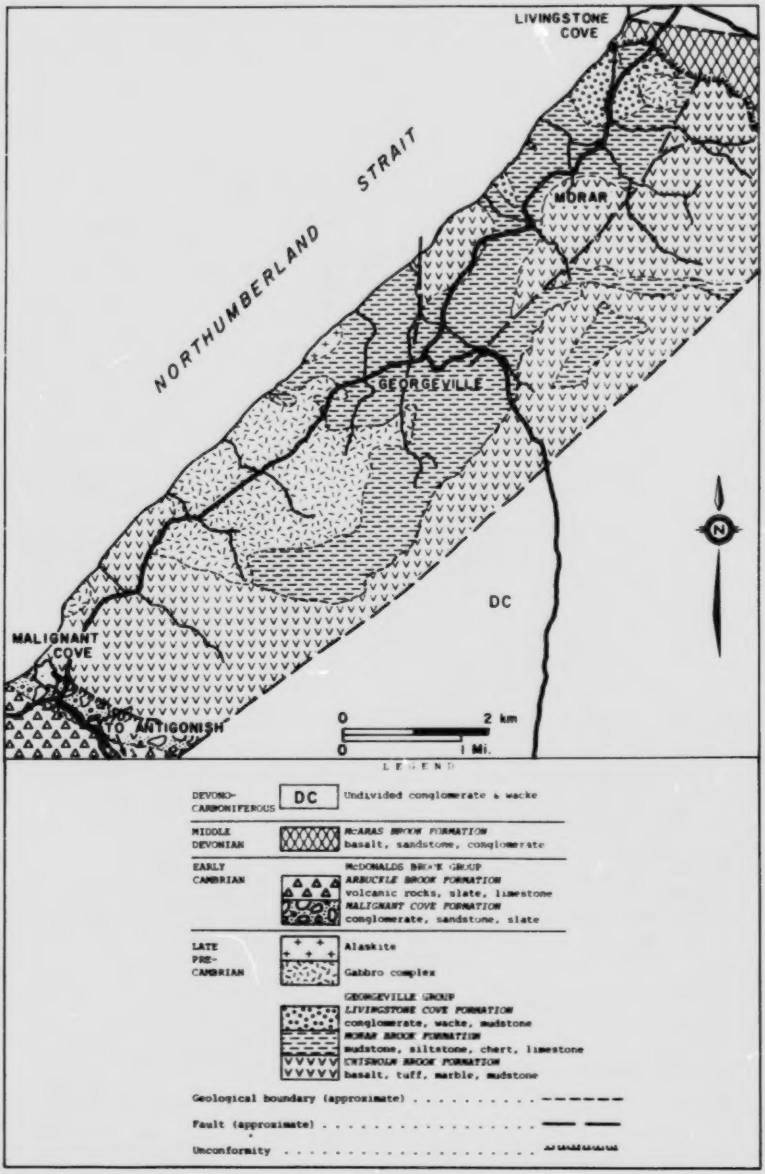

Figure 1. Geological map of the Georgeville area.

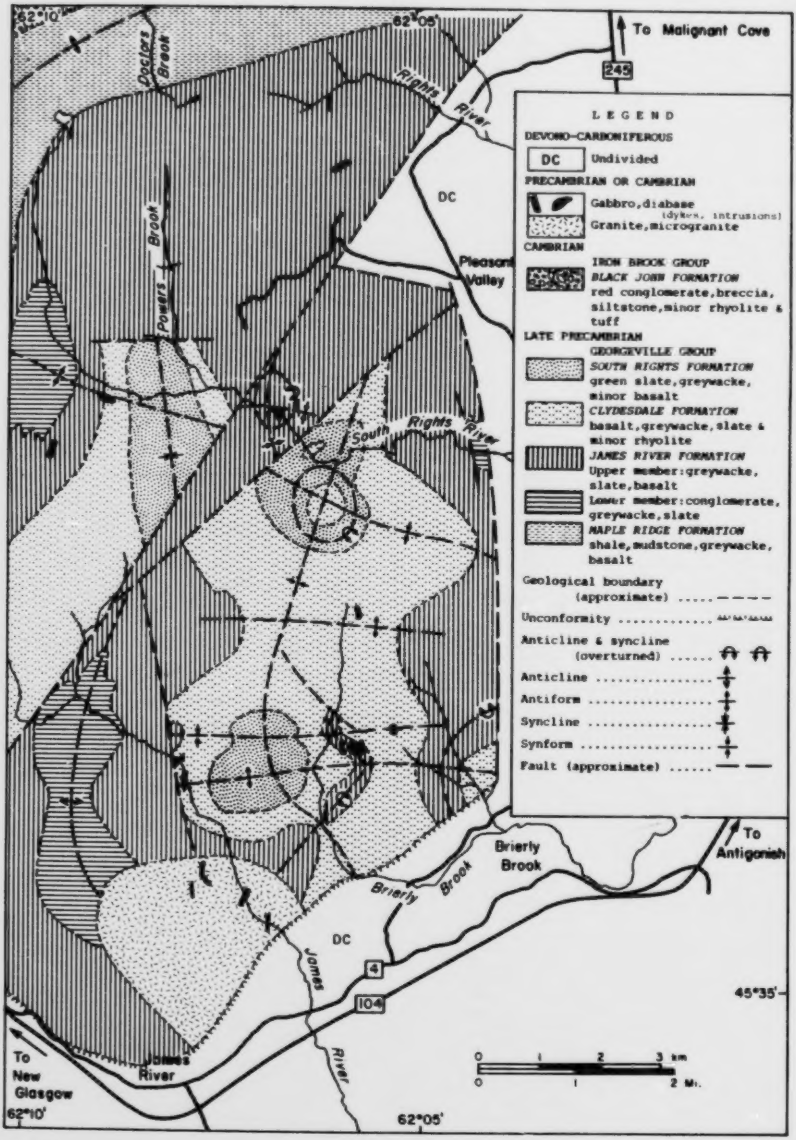

Figure 2. Geological map of the Browns Mountain area.

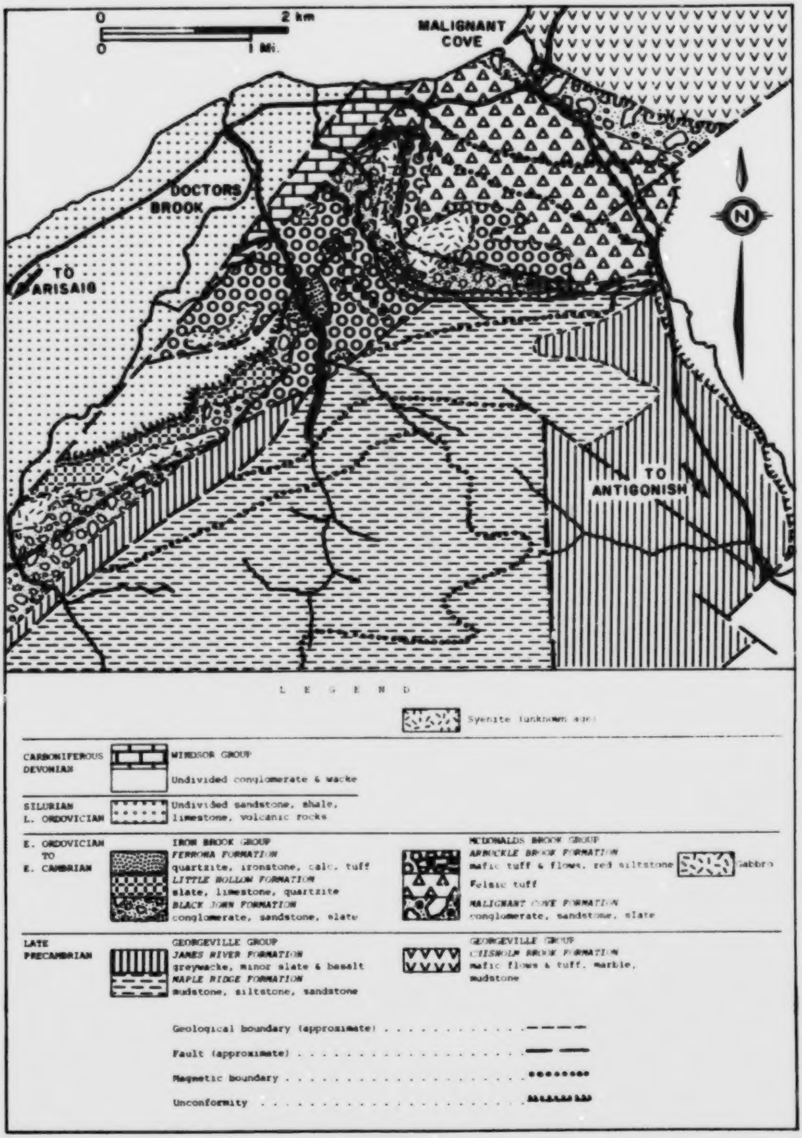

Figure 3. Geological map of the Malignant Cove area.

ational; the boundary is placed at the top of the highest volcanic unit. These rocks are overlain conformably by the Livingstone Cove Formation containing conglomerates interbedded with the black mudstone and siltstone. The conglomerate horizons often have channelled bases and the clasts are generally supported by a sandy volcaniclastic matrix exhibiting no obvious grading. Pebbles in the conglomerates are predominantly of volcanic origin with some granite and locally derived black mudstone clasts. The base of the Livingstone Cove Formation is placed where conglomerate becomes common in the section. The base of the Georgeville Group in the coastal strip is obscured by a gabbroic complex and the top is truncated by an angular unconformity at the base of the Middle Devonian McAras Brook Formation.

Inland, the Maple Ridge Formation is correlated with the Morar Brook Formation (Table 1). It consists mainly of black and green slate interbedded with greywacke and minor basalt. It is conformably overlain by the James River Formation which is regarded as a facies equivalent of the Livingstone Cove Formation. At the base, this Formation is mainly volcaniclastic conglomerate, greywacke and slate, grading upwards through green wacke, slate and minor basalt into predominantly green laminated slate at the top. This unit is, in turn, conformably overlain by the Clydesdale Formation made up of submarine mafic volcanic rocks interbedded with some greywacke, slate and rare rhyolite flows. This Formation grades up into the South Rights Formation consisting mainly of slate with minor greywacke and basalt.

The environment of deposition of the Georgeville Group is inferred to have been a quiet deep-water basinal area into which volcaniclastic flysch deposits entered by mass flow with detritus supplied by erosion of rapidly rising volcanic highlands. The marble horizons are deduced to have been deposited in shallow seas fringing volcanic islands.

During the Late Hadrynian Cadomian Orogeny the Georgeville Group was deformed first by NW-SE, tight to isoclinal, recumbent folds with a weak axial plane cleavage defined by chlorite, sericite and biotite and then refolded by NE-SW and E-W upright folds. This was accompanied by greenschist facies metamorphism. Plutonism is sporadic and mainly gabbroid in composition. A post-tectonic gabbroic complex and alaskite intruded the Georgeville Group in the coastal strip. The alaskite has been dated by Cormier (1979) using Rb/Sr on whole rocks at 508 ± 10 Ma. However, a K/Ar age on muscovite (%K=7.83) from the alaskite yielded an age of 604 ± 14 Ma (Wanless, personal communication, 1979). The older age is preferred by the authors and the younger Rb/Sr age is attributed to the extensive deuteric alteration evident in the alaskite which modified both the age and produced the unusually high initial 87Sr/86Sr ratio (0.7403 ± 0.0254). Tectonic interpretation of the Antigonish Highlands subzone (Keppie, 1979) suggests that it represents part of a deformed back-arc basin.

The Cambrian rocks in the northern Antigonish Highlands have been divided into two groups: the mainly sedimentary, 225 m thick Iron Brook Group and the predominantly volcanic, 500 m thick McDonalds Brook Group (Figure 3). At the base of each Group, red, nonmarine conglomerate, sandstone and slate (Black John and Malignant Cove Formations) unconformably overlie rocks of the Georgeville Group (Table 1). In the Iron Brook Group, these redbeds are conformably overlain by interbedded red, green and black slate, thin limestone and quartzite. The limestones have yielded a late Early Cambrian faunule of trilobites, and paraconodonts (G. S. Nowlan, written communication, 1979). Equivalent rocks in the McDonalds Brook Group are the bimodal, rift or anorogenic, strongly alkalic, within-plate volcanic rocks and thin interbedded units of red slate, siltstone and fossiliferous limestone of the Arbuckle Brook Formation. Many of the dykes in older rocks are feeders to these volcanic rocks. The Little Hollow Formation is concordantly overlain by interbedded quartzite, lateritic ironstone and calcareous tuff of the Ferrona Formation which has yielded some inarticulate brachiopods: *Obolus (lingulobus) spissa* and *Lingulella(?)* of late Cambrian-early Ordovician age (Williams, 1914). This suggests that a diastem is present in the succession during the middle Cambrian.

Some parts of the Iron Brook and MacDonalds Brook Groups were deformed by recumbent F1 folds with a penetrative axial plane cleavage defined by chlorite, muscovite and biotite, and accompanying thrusts during the Taconian Orogeny. This coincides with a major break in the stratigraphy in the Avalon Zone between Arenig and latest Ordovician times (Table 1).

In the Iron Brook, the Silurian Beechhill Cove Formation lies unconformably upon the Ferrona Formation. Following the deposition of the Silurian Arisaig Group and the Early Devonian Knoydart Formation, all of the rocks were deformed during the Acadian Orogeny. This produced upright NE-SW folds accompanied by an axial plane fracture or crenulation cleavage. In the Cambro-Ordovician rocks, these Acadian structures form the second phase and are superimposed upon the earlier recumbent Taconian folds and thrusts (Figure 3).

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GEOLOGY OF THE GUYSBOROUGH AREA, GUYSBOROUGH COUNTY, NOVA SCOTIA*

P. K. Smith

ABSTRACT

In the Guysborough area the Devono-Carboniferous Horton Group is subdivided into five formations. The lower two formations, Glenkeen and St. Francis River Formations are facies equivalents consisting of coarse grey polymictic conglomerate, massive quartz sandstone and minor blue-grey siltstone. The overlying unit, Clam Harbour River Formation, is a distinctive greyish-green, strongly cleaved siltstone unit with characteristic thinly interbedded buff weathered dolomitic limestone. Overlying the Clam Harbour River Formation are bluish-grey siltstone, greyish sandstone, and grey polymictic conglomerate of the Tracadie Road Formation. The upper unit, the Hadley Cove Formation, consists of dark grey shales with interbedded limy siltstones overlain by red and green cleaved siltstones. These Formations are overlain conformably and disconformably by younger Windsor Group and Canso Group strata.

These strata have all been deformed by north-south trending open, flat lying assymetric folds. Later block faulting has rotated some folds. Triassic and Pleistocene strata unconformably overlie the area.

Mineralization consists of Fe, Cu, Zn, and Ba, with significant amounts of La, Nd, Ce and Th in one specimen.

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* Paper in preparation

CREIGNISH HILLS PLUTON

R. M. Campbell*

INTRODUCTION

The Creignish Hills pluton is a composite dioritic-granitic intrusion in southwestern Cape Breton Island, located about 18 km north of Port Hastings (Figure 1). The pluton was included in basic geological mapping of the area by Ferguson and Weeks (1950), Kelley (1968), and Milligan (1970). It intruded Precambrian rocks of the George River Group which had probably been regionally metamorphosed to some degree before intrusion of the pluton. It is also shown to intrude a series of volcanic and metasedimentary rocks which may be partly or entirely of George River age (Ferguson and Weeks, 1950) or which may be Paleozoic in age (Kelley and MacKasey, 1965). It is overlain unconformably by Carboniferous sedimentary rocks. On the basis of field evidence the age of the intrusion is Devonian and/or earlier (Ferguson and Weeks, 1950; Kelley, 1968; Milligan, 1970). An age of 540±60 Ma was determined for a single sample of granite pegmatite from McAskill Brook, which lies to the north of the Creignish Hills pluton, by the Rb/Sr method, thus suggesting an age of Precambrian to Cambrian for intrusive activity in the Creignish Hills (Cormier, 1972, modified by Keppie and Smith, 1978).

Geological mapping and sampling of the Creignish Hills pluton were undertaken during May and June 1979. Mapping was done on a scale of 1:31,680. Exposure is generally poor, being mainly restricted to streams and road cuts. Approximately 300 samples were collected, of which 27 were selected on the basis of lithology and location for chemical analyses. This work will form the basis of a M.Sc. thesis project at Acadia University. Further field work is planned for the spring of 1980 to further define the nature of contacts within the pluton and between the pluton and surrounding country rock.

GENERAL GEOLOGY

The pluton is elongate in shape, approximately 22 km long with a maximum width of about 6 km in the central region decreasing toward both ends (Figure 1). It is approximately 110 km^2 in area. Detailed mapping distinguished three main phases: quartz monzodiorite, biotite-hornblende granite, and quartz-rich granite. The quartz-rich granite appears as a subelliptical plug in the biotite-hornblende granite and exhibits a chilled margin indicating that it is the youngest phase. The contact between the biotite-hornblende granite and the quartz monzodiorite was not observed in the field and hence their relationship is uncertain. The pluton is cut by numerous small dykes of aplitic, intermediate, and mafic composition.

The contacts with the host rocks of the George River Group are generally poorly exposed, but both the quartz monzodiorite and the biotite-hornblende granite contain inclusions and xenoliths of the George River Group. Carboniferous sedimentary rocks were seen to overlie the pluton nonconformably. The relationship of the pluton to the metasedimentary and volcanic rocks to the southwest is unclear at this time.

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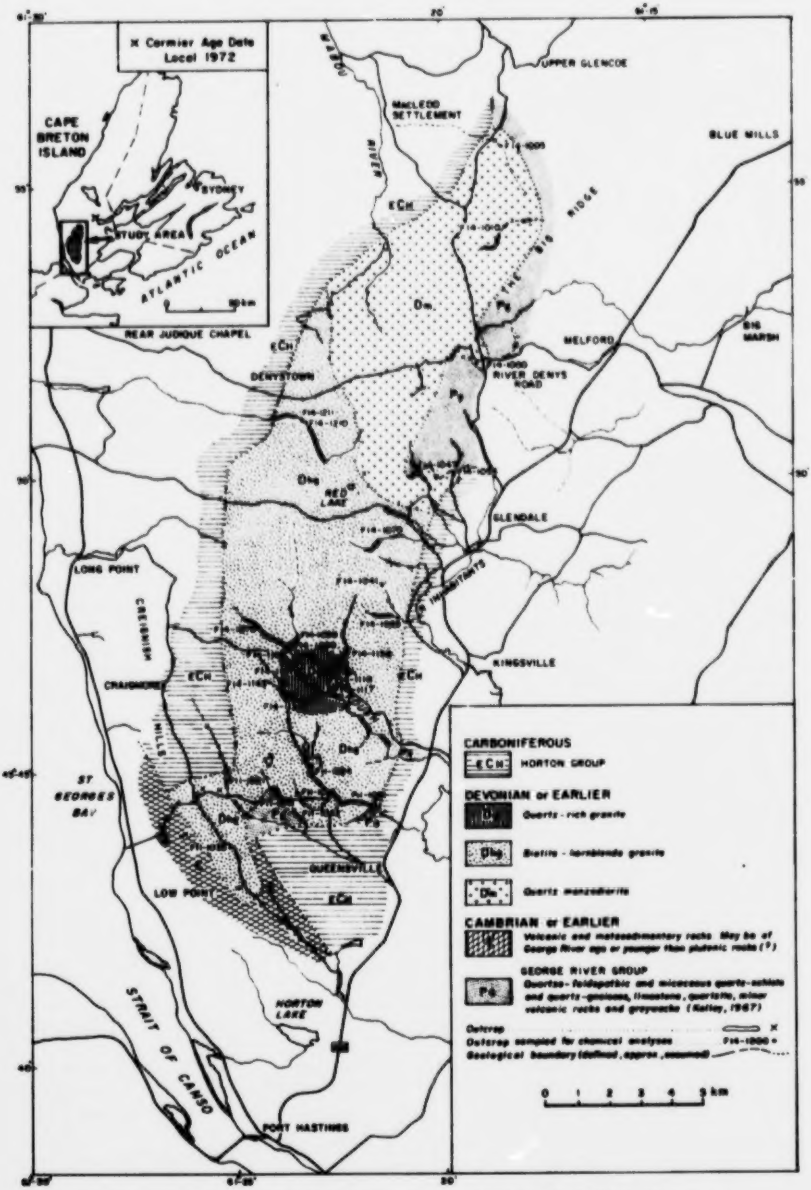

Figure 1. Geological map of the Creignish Hills pluton.

The geological contacts shown on Figure 1 are based on field mapping and aeromagnetic data for the area.

Quartz Monzodiorite

This phase forms an elongate body approximately 36 km^2 in area, which makes up the northern portion of the pluton. The rocks are dark to medium grey in colour and generally medium grained. The major minerals are quartz, plagioclase, microcline, orthoclase, biotite and hornblende. Accessories include abundant apatite and minor sphene and opaques (probably magnetite). The relative amounts of minerals in this phase varies throughout the pluton. The rock ranges from quartz monzonite through quartz monzodiorite to diorite.

Biotite-Hornblende Granite

This phase forms an elongate body with an approximate area of 70 km^2, which makes up the southern and largest portion of the pluton. The rocks are medium- to coarse-grained and mottled grey to pinkish in colour. They consist of quartz, orthoclase, perthite, plagioclase, biotite and hornblende. Accessories include apatite and zircon.

Quartz-rich Granite

This phase forms a subelliptical body about 4 km^2 in area within the central region of the biotite-hornblende granite. The rocks are fine grained and in places slightly porphyritic and generally pink in colour. They consist of quartz, orthoclase, plagioclase and biotite. Accessories are muscovite, zircon and apatite.

Aplitic and Intermediate Dykes

The pluton is cut by numerous, generally small, aplitic, and intermediate dykes with aplite dykes being the most abundant type. These vary in thickness from 30 cm to 10 m. They are found in all phases of the pluton, but appear to be most abundant in the biotite-hornblende granite. These dykes were not observed in the overlying Carboniferous sedimentary rocks and hence are thought to be late phases of the intrusive sequence.

Mafic Dykes

Mafic dykes were observed in both the pluton and the overlying Carboniferous sedimentary rocks and hence are thought to be Carboniferous or younger in age and not part of the plutonic sequence. These vary in width from 30 cm to 20 m.

Alteration

The minerals of all three phases are altered to varying degrees. The biotite and hornblende are generally partially chloritized. The feldspars are in some cases saussuritized.

On a larger scale, an area to the southeast of the quartz-rich granite in the biotite-hornblende granite is completely altered to epidote and hematite. Alteration may be associated with faulting in this area. Throughout, the pluton exhibits zones of intense alteration, generally to epidote. These are generally associated with areas which are highly fractured or sheared. Various samples exhibit cataclastic textures. These are generally in close proximity to geological boundaries either between plutonic phases or between the pluton and the surrounding country rock.

Mineralization

Magnetite mineralization occurs in the quartz monzodiorite and in inclusions of the George River Group near Upper Glencoe. Mineralization present is essentially magnetite with malachite staining. Exploration was carried out in the 1940's and in 1956, but the prospect proved uneconomic (Kelley, 1968, and Milligan, 1970).

Minor chalcopyrite and pyrite were observed associated with some of the mafic dykes cutting the pluton.

SUMMARY

The Creignish Hills pluton is a high-level composite stock, intruding predominantly Precambrian metamorphic rocks of the George River Group, in southwestern Cape Breton Island. Three main phases are present in the pluton: quartz monzodiorite, biotite-hornblende granite and a quartz-rich granite. The sequence of events is thought to be:

1) intrusion of quartz monzodiorite;
2) intrusion of biotite-hornblende granite;
3) intrusion of quartz-rich granite; and
4) intrusion of aplitic, and intermediate dykes.

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THE AGE OF THE KELVIN LAKE AND GILLIS BROOK FORMATIONS, CAPE BRETON ISLAND

P. K. Smith

Palynomorphs have been recovered from two localities in the Cambro-Ordovician strata in southeastern Cape Breton Island (Figure 1). The area is underlain by red polymictic conglomerate, sandstone, and shale with minor amounts of slate, volcanic rocks, and limestones. These strata rest with angular unconformity upon older, deformed, mainly volcanic rocks of the Upper Precambrian Fourchu Group (Smith, 1978).

One productive sample comes from the Gillis Brook Formation on Gillis Brook approximately 3 km southwest of Gillis Lake (Specimen No. F16-6387 MO Latitude 45°52'20" Longitude 60°20'50") (Figure 1). The sample is a weakly foliated grey siltstone interbedded with grey conglomerate and basaltic flows. It yielded the acritarch:

> *Polygonium* cf. *gracile* Vavrdova 1966 (Jenkins, W. A. M., written communication, 1979), a form characteristic of the Arenig Klabava Shales in Bohemia.

This same locality also yielded the brachiopod *Indiana* sp. which was assigned a Late Early to Middle Cambrian age (Weeks, 1954). The lack of agreement on the age is undoubtedly due to the poor assemblage. Further collecting may resolve this problem. However, at this time the author prefers to stand by his Middle Cambrian age assignment for the Gillis Brook Formation on stratigraphic grounds. Thus, the Gillis Brook Formation is overlain by the Victoria Bridge Formation, which is in turn overlain by the MacNeil Formation for which a Late Cambrian age is relatively well established (Hutchinson, 1952).

The second productive sample comes from the Kelvin Lake Formation on Miller Brook about 700 m west of McDougalls Lake (Specimen No. F16-6342 MO Latitude 45°51'26" Longitude 60°20'35") (Figure 1). The sample comes from an isolated locality of moderately well cleaved, grey, slaty siltstone.

> *Polygonium* cf. *gracile* Vavrdova 1966 was also recovered from this sample (Jenkins, W. A. M., written communication, 1979).

Thus, it is inferred that this locality occurs in a fault slice of Gillis Brook Formation surrounded by Kelvin Lake Formation (Smith, 1978).

ACKNOWLEDGMENTS

The author would like to thank Dr. W. A. M. Jenkins of Petro-Canada in Calgary for his assistance in preparing this article.

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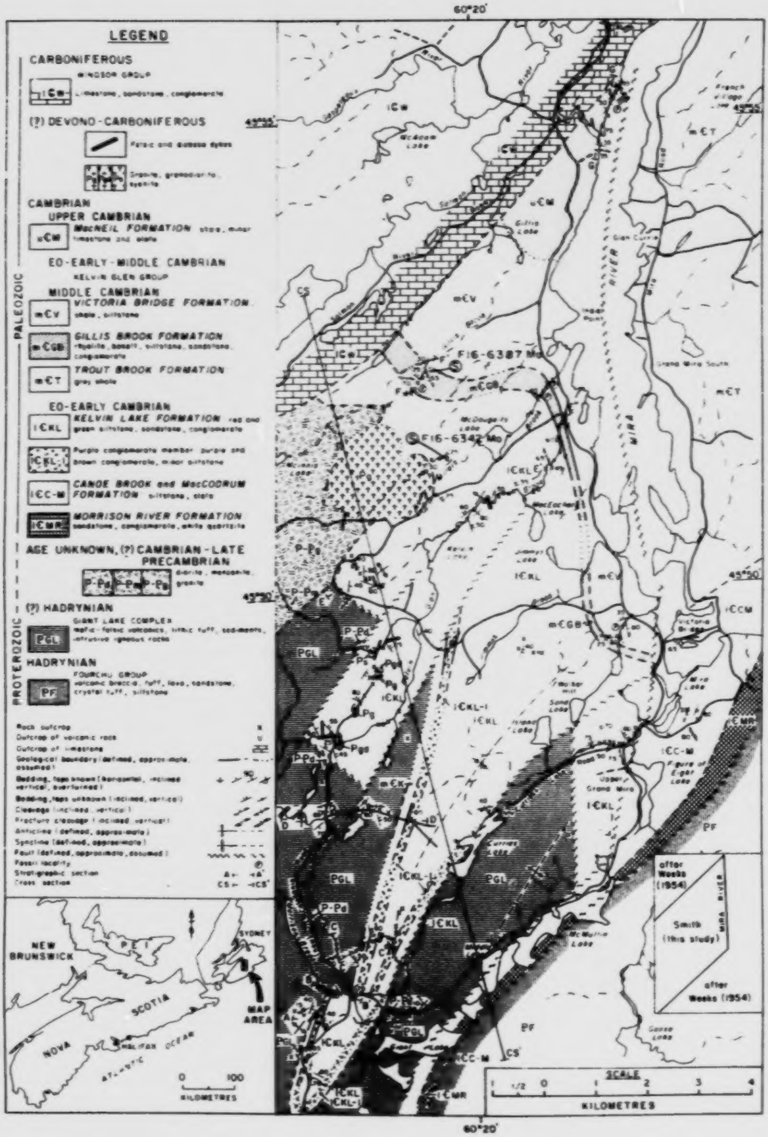
60°20'
LEGEND
CARBONIFEROUS
WINDSOR GROUP
ICw
Limestone, sandstone, conglomerate
(?) DEVONO-CARBONIFEROUS
Felsic and diabase dykes
Granite, granodiorite, syenite
CAMBRIAN
UPPER CAMBRIAN
uCM
MacNEIL FORMATION slate, minor limestone and slate
EO-EARLY-MIDDLE CAMBRIAN
KELVIN GLEN GROUP
MIDDLE CAMBRIAN
mCV
VICTORIA BRIDGE FORMATION shale, siltstone
mCGB
GILLIS BROOK FORMATION rhyolite, basalt, siltstone, sandstone, conglomerate
mCT
TROUT BROOK FORMATION grey shale
EO-EARLY CAMBRIAN
ICKL
KELVIN LAKE FORMATION red and green siltstone, sandstone, conglomerate
ICKL-I
Purple conglomerate member: purple and brown conglomerate, minor siltstone
ICC-M
CANOE BROOK and MacCODRUM FORMATION siltstone, slate
ICMR
MORRISON RIVER FORMATION sandstone, conglomerate, white quartzite
AGE UNKNOWN, (?) CAMBRIAN-LATE PRECAMBRIAN
P-Pd P-Pm P-Pg
diorite, monzonite, granite
(?) HADRYNIAN
GIANT LAKE COMPLEX
PGL
mafic-felsic volcanics, lithic tuff, sediments, intrusive igneous rocks
HADRYNIAN
FOURCHU GROUP
PF
volcanic breccia, tuff, lava, sandstone, crystal tuff, siltstone
PALEOZOIC
PROTEROZOIC
45°55'
45°50'
F16-6387 Mo
F16-6342 Mo
CS
CS'
MIRA RIVER
PF
after Weeks (1954)
Smith (this study)
after Weeks (1954)
NEW BRUNSWICK
P.E.I.
SYDNEY
NOVA SCOTIA
HALIFAX
ATLANTIC OCEAN
MAP AREA
0 100
KILOMETRES
SCALE
1/2 0 1 2 3 4
KILOMETRES
60°20'

Figure 1. "Ⓢ" New spore localities.

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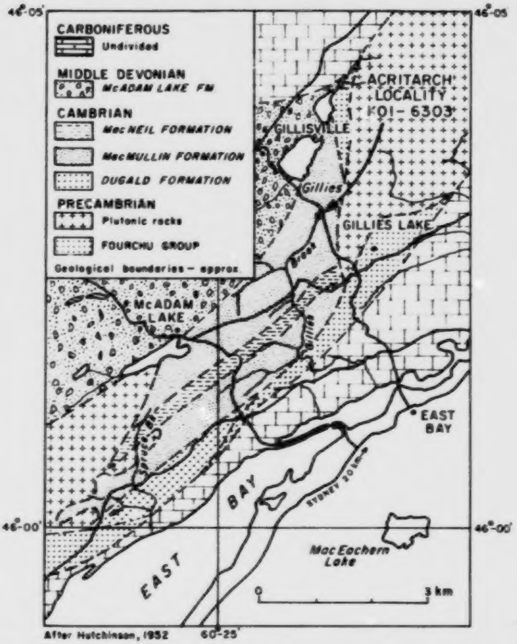
TREMADOCIAN ACRITARCHS FROM GILLIS BROOK, BOISDALE HILLS, CAPE BRETON ISLAND

J. D. Keppie

A shale sample from the MacMullin Formation in Gillis Brook just west of the road between Gillisville and Gillies Lake (Figure 1) contained some rare poorly preserved acritarchs referable to the genera *?Acanthodiacrodium* and *Priscogalea* (W.A.M. Jenkins, written comm., 1979).



After Hutchinson, 1952

Figure 1. Geological map of part of Boisdale Hills.

The stratigraphic range of *Acanthodiacrodium* is Tremodoc to Llanvirn (lower Ordovician). That of *Priscogalea* is more restricted, however, and in Britain, Belgium, Bohemia and Algeria appears to lie within the Tremadoc. The available evidence is somewhat limited, but strongly suggests that the material is of Tremadoc age.

These rocks were previously assigned to the MacMullin Formation of Middle Cambrian age (Hutchinson, 1952) on the basis of lithostratigraphic criteria, because no fossils had been recovered from the Formation in this area. However, Late Cambrian trilobites were recovered from black shales and limestones of the MacNeil Formation in Gillis Brook and Spruce

Brook by Hutchinson (1952) who assigned them to the uppermost Upper Cambrian *Peltura* Zone. Thus, the age of the acritarchs is consistent with this determination and suggests that the rocks from which they were recovered should not be included in the Middle Cambrian MacMullin Formation.

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FOSSILS FROM SCHOOL BROOK COVE, CAPE GEORGE, NOVA SCOTIA

J. D. Keppie

Conodonts have been recovered from two samples of limestone (GSC localities 96154, 96166) from the east side of School Brook Cove (Figure 1) in interbedded sandstone, shale, tuff, limestone and quartzite. This sequence was previously regarded as mid to late Ordovician (Boucot, et al., 1974), but the conodonts suggest an Early Silurian age. Thelodonts have also been recovered from both samples and GSC Locality 96154 also yielded a few ostracodes. G. S. Nowlan (Geological Survey of Canada, Ottawa) has identified the fauna from these localities and the following is his report.

"The samples yielded almost 200 moderately well preserved specimens which are brownish grey in colour, possibly corresponding to Colour Alteration Index (CAI) 3 or higher of Epstein, et al., 1977. The fauna is of Early Silurian (Llandovery) age and is representative of the upper part of the Idwian and lower part of the Fronian stages (Llandovery B_1-C_1,C_2). Conodont species recovered from the samples include:

Distomodus kentuckyensis Branson and Branson
"*Drepanodus suberectus*" Branson and Mehl (*sensu* Rexroad, 1967)
Icriodella discreta Pollock, Rexroad and Nicoll
Ozarkodina hassi (Pollock, Rexroad and Nicoll)
O. oldhamensis (Rexroad)
?*Walliserodus curvatus* (Branson and Branson)

This fauna is best correlated with the zones established for the Llandovery Series by Nicoll and Rexroad (1969) in North America and by Aldridge (1972) in the Welsh Borderlands. All the taxa recovered have been reported from both the *Icriodina irregularis* Assemblage Zone of Nicoll and Rexroad (1969) and the *Icriodella discreta-I. deflecta* Assemblage Zone of Aldridge. The *Icriodina irregularis* Assemblage Zone is now known as the *Distomodus kentuckyensis* Zone as a result of the taxonomic work of Cooper (1975) who placed the form species *I. irregularis* in the multielement species *Distomodus kentuckyensis*. These two assemblage zones are considered to be correlative (Aldridge, 1972; Cooper, 1975). In the type area for the Llandovery Series the *I. discreta-I. deflecta* Assemblage Zone occupies at least the upper part of the Idwian and part of the C_{1-2} interval of the Fronian (Aldridge, 1972). This interval may correlate with the upper part of Walliser's (1962, 1964) Bereich 1 in the Carnic Alps although this is not certain (Schönlaub, 1971; Aldridge, 1972).

"Thelodonts, the dentinal scales of jawless fishes (Agnatha) were recovered from both samples. Detailed histological examination is necessary for specific identification (Gross, 1967; Turner, 1973) and so these specimens have been tentatively identified at the generic level as *Logania*? and *Thelodus*? Thelodonts of Early Silurian age have been reported from the Welsh Borderlands (Aldridge and Turner, 1975) and from Arctic Canada (Turner and Dixon, 1971). A discussion of the biostratigraphic significance of Siluro-Devonian thelodonts has been provided by Turner (1973).

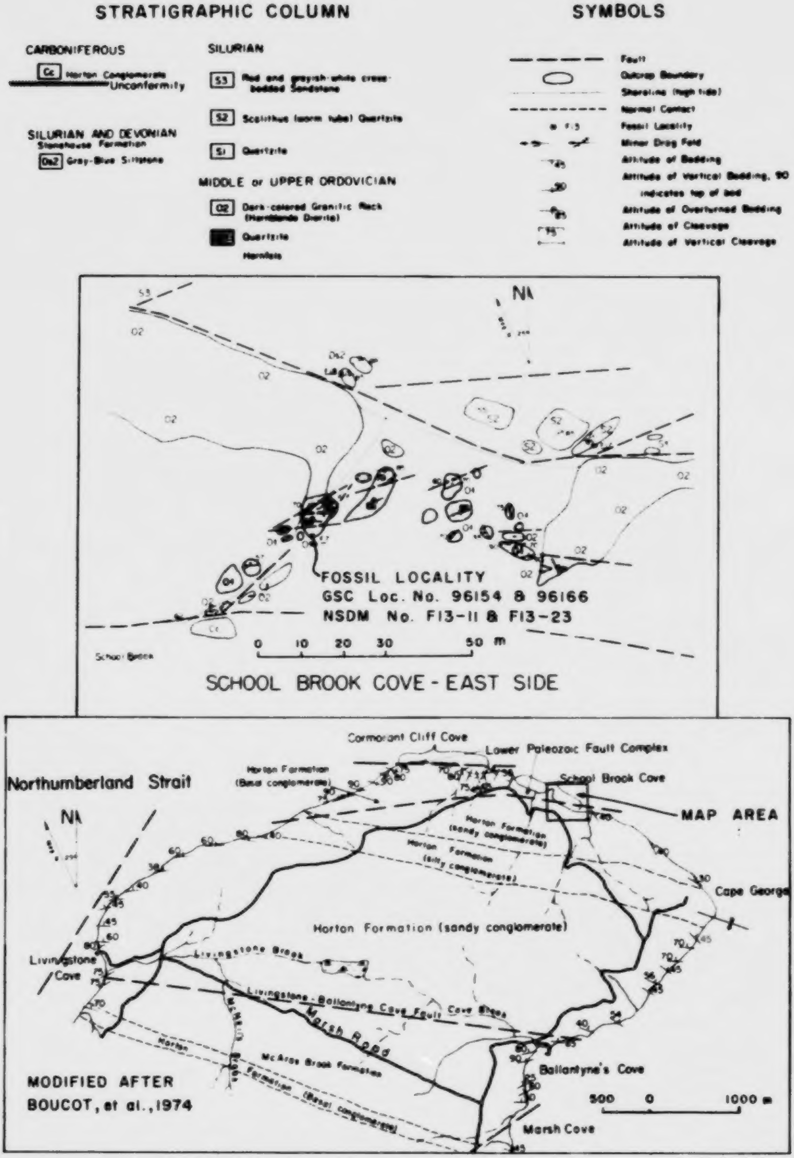
STRATIGRAPHIC COLUMN
CARBONIFEROUS
Cc Horton Conglomerate
Unconformity
SILURIAN AND DEVONIAN
Stonehouse Formation
Ds2 Gray-Blue Siltstone
SILURIAN
S3 Red and greyish-white cross-bedded Sandstone
S2 Scolithus (worm tube) Quartzite
S1 Quartzite
MIDDLE or UPPER ORDOVICIAN
O2 Dark-colored Granitic Rock (Hornblende Diorite)
Quartzite
Hornfels
SYMBOLS
Fault
Outcrop Boundary
Shoreline (high tide)
Normal Contact
Fossil Locality
Minor Drag Fold
Attitude of Bedding
Attitude of Vertical Bedding, 90 indicates top of bed
Attitude of Overturned Bedding
Attitude of Cleavage
Attitude of Vertical Cleavage
N
FOSSIL LOCALITY
GSC Loc. No. 96154 & 96166
NSDM No. F13-11 & F13-23
0 10 20 30 50 m
School Brook
SCHOOL BROOK COVE - EAST SIDE
Cormorant Cliff Cove
Lower Paleozoic Fault Complex
Horton Formation (Basal conglomerate)
School Brook Cove
Northumberland Strait
MAP AREA
Horton Formation (sandy conglomerate)
Horton Formation (silty conglomerate)
Cape George
Horton Formation (sandy conglomerate)
Livingstone Cove
Livingstone Brook
Livingstone - Ballantyne Cove Fault
Cove Brook
Marsh Road
McArras Brook Formation
Horton Formation (Basal conglomerate)
Ballantyne's Cove
Marsh Cove
500 0 1000 m
MODIFIED AFTER BOUCOT, et al., 1974

Figure 1. Location of fossil samples, School Brook Cove, east side, Cape George, Nova Scotia.

"A few ostracodes were recovered from GSC locality 96154. M. J. Copeland (Geological Survey of Canada, Ottawa) has identified these specimens as cf. *Bairdiacypris* sp. and *Jupiterella*? sp. and considers them similar to specimens recovered from the basal shale of Jupiter Formation, Anticosti Island, Quebec (Copeland, 1974; personal communication, 1979)."

Thus, these rocks are equivalent to the Beechhill Cove Formation and the lowest part of the Ross Brook Formation in the Arisaig area, and indicate somewhat similar shallow-water environment at this time. The revised age assignment of these rocks means that there are no post-Arenig to uppermost pre-Ordovician rocks known anywhere in the Avalon Zone in the northern Appalachians. Thus, this period represents a major regional unconformity and coincides in time with the Taconian Orogeny.

These Llandoverian rocks are cut by a differentiated intrusive sheet varying from gabbro at its base to syenite at the top (Figure 1). Thus, this intrusion is no older than Late Llandoverian in age. These rocks are separated on the north by a fault which downthrows rocks of Late Silurian-Early Devonian age (Boucot, et al., 1974). All of these rocks occur in a complex east-west fault zone.

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GEOCHEMISTRY OF GRANITOID PLUTONS OF CAPE BRETON ISLAND

S. M. Barr*

Granitoid plutons are abundant in Cape Breton Island and yet few data are available concerning lithology, geochemistry, age, or economic potential. Some are known to be mineralized or associated with mineralization. In 1978 a study of the geology and geochemistry of granitoid plutons in Cape Breton Island was initiated. One of the purposes of this project is to assess the economic potential of these plutons using aspects of their petrology and/or geochemistry as indicators of the possibility of economic mineralization. Simultaneously, valuable information will be obtained concerning petrology, age, and petrogenesis of these plutons, about which little is currently known.

During the summer of 1978, six plutons were mapped in detail and sampled for petrographic and geochemical studies (Figure 1). Preliminary reports describing the geology of these plutons based primarily on field data have previously been presented (Barr, et al., 1979). During late 1978 and 1979, petrographic studies and chemical analyses of over 300 samples were completed. All samples were analyzed for Si, Ti, Al, Fe^{3+}, Fe^{2+}, Mn, Mg, Ca, Na, K, H_2O^+, H_2O^-, CO_2, As, Ba, Cu, F, Mo, Pb, Rb, S, Sn, Sr, U, W, and Zn. Selected representative samples were also analyzed for B, Be, Bi, Cd, Co, Li, Nb, Ni, Sb, Y, and Zr.

Included in the initial phase of the study are three plutons of Precambrian-Cambrian age, two apparently unmineralized (Huntington Mountain and Kellys Mountain) and one with known Cu-Mo mineralization (St. Anns Mountain). They consist of older "dioritic complexes" ranging from diorite to granite, but dominantly quartz diorite and granodiorite. These were intruded by large masses of comparatively homogeneous leucogranite grading to biotite granite, with minor fine grained granite and aplite. The St. Anns Mountain pluton differs from the other two in that the granodioritic rocks are extensively altered in some areas, and bodies of biotite quartz monzonite with Cu-Mo mineralization are gradational with the leucogranite.

The Cape Smoky pluton is possibly of Ordovician-Devonian age and has no known mineralization. It consists of a large body of biotite granite (petrographically distinct from the leucogranite/biotite granite of older plutons) with minor biotite quartz monzonite. It intruded diorite, quartz diorite, and granodiorite as well as an older suite of similar intermediate to mafic plutonic rocks.

The Devonian White Point pluton is distinctly different from the older plutons. It consists of relatively homogeneous muscovite-biotite granite (with gradations to granodiorite) intruded by very abundant pegmatite and aplite dykes. No mineralization is known to occur. In contrast the Devonian Gillis Mountain pluton has associated Cu-Mo mineralization with prophyry-type affinities (Kirkham and Soregaroli, 1975). It is a composite pluton consisting of quartz monzodiorite and two granitic phases. All three phases are mineralized. The geology and geochemistry of the Gillis Mountain pluton were described in detail by O'Beirne (1979).

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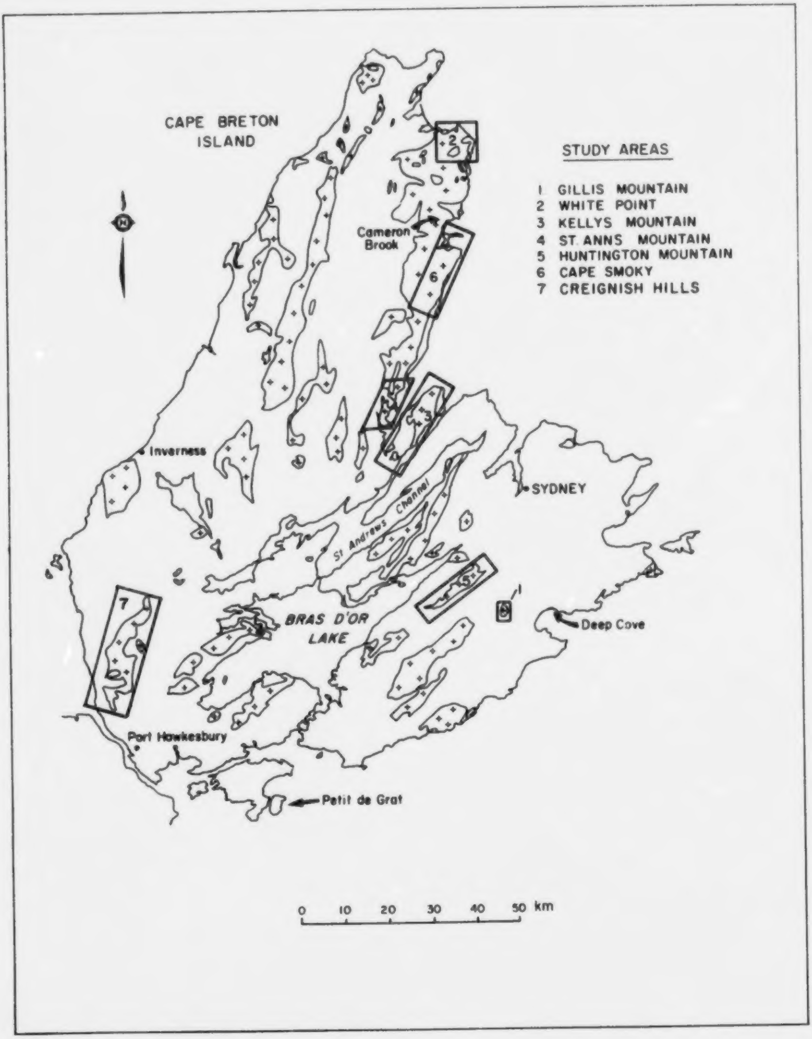

Figure 1. Pluton location map and distribution of granitoid rocks, Cape Breton Island.

In addition to these six plutons, some mapping and sampling were done at the small granitic Petit de Grat and Deep Cove plutons, the latter of which is intensely altered and rich in Cu-Mo-Bi mineralization.

All plutons studied are remarkably similar in major element geochemistry. All show typical calc-alkalic patterns, with decreasing TiO_2, Al_2O_3, $FeO+Fe_2O_3$, MnO, MgO, CaO, and P_2O_5 and increasing K_2O with increasing SiO_2. Na_2O shows little change. Concentrations of major elements are consistent with petrography and no differences in concentrations or patterns occur between mineralized plutons (St. Anns Mountain, Gillis Mountain, Deep Cove) and plutons which are not known to be mineralized (Huntington Mountain, Kellys Mountain, Cape Smoky, White Point, Petit de Grat).

Among the trace elements, F, Rb, Sr, U and Sn show generally similar concentrations and patterns in all plutons. However As, Ba, Cu, Mo, Pb, S, and Zn show higher mean values, wider ranges, and larger standard deviations in all phases of the Gillis Mountain and Deep Cove plutons. Only Cu and Pb show higher mean values, wider ranges, and larger standard deviations in the St. Anns Mountain pluton, but these differences, although small, are detected in all phases, not only the biotite quartz monzonite with which the mineralization is known to occur. Hence tentative conclusions suggest that plutons with potential for Cu-Mo mineralization will show high and variable "background" values in Cu and Pb and possibly other metallic elements, S and Ba.

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GEOLOGY OF THE GILLIS MOUNTAIN PLUTON, CAPE BRETON ISLAND, NOVA SCOTIA

A. M. O'Beirne*

ABSTRACT

The Gillis Mountain pluton is a high-level composite granitic stock intruding Lower to Middle Cambrian shales and siltstones in southeastern Cape Breton Island. A Rb/Sr isochron indicates an age of 384±10 Ma for the pluton. Petrographic and geochemical studies show that the pluton consists of a comagmatic, differentiated suite, in which the sequence of intrusion is: (1) quartz monzodiorite; (2) porphyritic granite; (3) fine grained granite; and (4) late-stage porphyries and aplites. The initial $^{87}Sr/^{86}Sr$ ratio of 0.7032±0.0018, is consistent with derivation from the mantle or from a primitive lower crustal material.

Associated with the Gillis Mountain pluton is porphyry-type Cu-Mo mineralization and related pervasive potassic alteration. Data from the pluton suggest the usefulness of chemical indicators in detecting the presence of similar mineralization associated with other granitoid rocks in the region. These data include: Cl contents of biotites; higher than average abundance of S, Mo and possibly Cu; and the degreee of variance of the ore-related elements.

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GRANITOID AND OTHER PLUTONIC ROCKS OF NOVA SCOTIA***

D. B. Clarke*, S. M. Barr** and H. V. Donohoe

ABSTRACT

Nova Scotia can be divided into three distinct areas of plutonic emplacement, namely Cape Breton Island, the mainland north of the Glooscap Fault, and the mainland south of the Fault. Both Cape Breton Island and the northern mainland are characterized by episodes of plutonism in the Late Precambrian (∿600 Ma), Cambro-Ordovician (600-500 Ma), and Late Devonian-Early Carboniferous (365-340 Ma). These episodes are characterized by diorite-granite associations (especially in the northern mainland and the oldest plutons on Cape Breton Island) or granites alone (Cape Breton Island). Most plutons north of the Glooscap Fault are approximately alumina-saturated and thus have little or no normative corundum. In contrast, the intrusive history south of the Glooscap Fault is confined to a short period of time (375-355 Ma), and all plutons are highly alumina-oversaturated resulting in various combinations of modal biotite, muscovite, andalusite, cordierite and garnet. Intense deformation of the southern plutons in the vicinity of the Glooscap Fault points to significant post-intrusive movement on the Fault. This deformation, combined with the poor correlation between the intrusive histories north and south of the Fault, may indicate that the post-plutonic displacement amounted to hundreds of kilometres, and resulted in the juxtaposition of two very different plutonic regions.

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*** Paper in press; presented at the International Geological Correlation Project Annual Meeting in September, 1979, Blacksburg, Virginia.

CARBONATE BANKS OF THE GAYS RIVER FORMATION IN CENTRAL NOVA SCOTIA*

P. S. Giles, R. C. Boehner and R. J. Ryan

ABSTRACT

Carbonate banks which are regionally widespread, but only locally developed, constitute one facies of the Gays River Formation, the basal unit of the Visean Windsor Group in the Musquodoboit Basin and on the southern flanks of the Shubenacadie Basin in southern Nova Scotia. Lithologically, they are characterized by abundant algal bindstone and bafflestone with associated skeletal packstone and wackestone. Their high degree of lithologic and faunal similarity indicates a common sedimentologic history for each of the banks examined. The relative proportions of major constituent faunal groups, the scarcity of plicate and costate brachiopods, the absence of representatives of the phylum Echinodermata, and the presence of newly reported genera of Gastropoda and Bryozoa, are biostratigraphic indicators which may distinguish carbonate banks of the Gays River Formation from similar carbonate banks at higher stratigraphic levels within the Windsor Group.

In the southern part of the Shubenacadie Basin and in the Musquodoboit Basin, carbonate banks have been found only in areas where the Windsor Group oversteps the Horton Group and rests upon rocks of the Meguma Group. They rest with equal frequency on both slate and metagreywacke. Banks overlain by terrigenous rocks on the southeastern margin of the Musquodoboit Basin are distinct in that they contain abundant calcareous algae of the genus *Koninckopora*. Otherwise, they are similar in character to more northwesterly banks which are overlain by thick sulphate evaporites.

Mineralization with sulphides of lead and zinc is most evident in, but not wholly restricted to, the Gays River bank. Sulphides occur mainly as open-space fillings in what has been described as a low temperature, Mississippi Valley type deposit. Migration of metal-bearing fluids through an east-west trending fracture zone is tentatively proposed to explain the localization of these sulphides.

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* Nova Scotia Department of Mines Paper 79-7.

STRATIGRAPHY AND DEPOSITIONAL HISTORY OF THE MARINE EVAPORITES IN THE LOWER CARBONIFEROUS WINDSOR GROUP, SHUBENACADIE AND MUSQUODOBOIT STRUCTURAL BASINS, NOVA SCOTIA, CANADA*

R. C. Boehner

The Windsor Group contains a major proportion of evaporite rocks including anhydrite, gypsum and halite. Three major depositional cycles are recognized.

The lower cycle is dominated by restricted hypersaline subaqueous marine evaporite deposition in a preformed basin, and is characterized by a thin basal dolostone overlain by a thick massive anhydrite and halite with thin anhydrite and siltstone interbeds. In marginal areas the anhydrite locally intertongues with terrigenous derived clastic rocks. Basinward, precipitation of anhydrite preceded halite which was localized in a shrinking basin adjacent to a contemporaneous subaerially exposed anhydrite surface.

The middle and upper cycles are more complex with repeated minor cycles of laterally extensive transgressive-regressive marine carbonate and terrigenous derived siliciclastic rocks with a variable, but generally large proportion of evaporite including anhydrite and minor halite. Anhydrite occurs as nodules in siltstone or carbonate, grading to coalescive nodular mosaic masses. The anhydrite associated with the halite is massive to locally laminated and halitic. Nodular anhydrite, both in situ and as transported clasts, has a diagenetic sabkha-type origin in low relief prograding coastal mud flats. The massive to laminated anhydrite, with or without stratified or herringbone crystal halite, was precipitated in hypersaline shallow pans and coastal lagoons.

Thick evaporites of the lower cycle progressively infilled the initial basin and effectively leveled topographic irregularity. This surface of low relief and gentle slope favoured shallow water and diagenetic evaporite deposition throughout the two subsequent cycles. Trends indicate increased evaporite deposition toward the northwest with a maximum in the Shubenacadie Basin and decreased, more localized evaporite deposition with time.

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*Abstract of paper presented to the 9th International Congress of Carboniferous Stratigraphy and Geology, University of Illinois, Urbana, Illinois, May, 1979.

MIDDLE TO LATE VISEAN STRATIGRAPHY AND PALEOGEOGRAPHY IN NOVA SCOTIA, CANADA*

P. S. Giles

The Middle to Late Visean Windsor Group typically comprises from five to seven formations, the equivalents of which can be recognized throughout Nova Scotia. These can be assigned to three major transgressive-regressive cycles, the earliest of which is characterized by the ascending sequence carbonate-anhydrite-halite-siltstone. Near paleobasin margins, terrigenous rocks complicate this sequence. Major cycles 2 and 3 were regionally more extensive than the first major cycle, and are typified by numerous laterally extensive marine carbonate members, associated with rocks typical of arid tidal flat and continental sedimentary environments.

The boundaries of the cycles, defined using lithologic criteria, coincide reasonably with biostratigraphic boundaries determined by independent studies of macrofauna, calcareous Foraminifera, conodonts, and palynomorphs. This coincidence suggests that the cycles are bound by approximate time planes, and constitute a useful framework for paleogeographic reconstruction.

Marine inundation of pre-existing basin and range topography in Visean time produced a vast inland sea covering much of Atlantic Canada. Upland areas of various sizes stood above sea level and contributed terrigenous detritus on their flanks. At transgressive maxima, these areas were reduced in size, and connections with the main Carboniferous sea were maintained. During regressive periods, the inland sea was effectively isolated from the normal marine environment, resulting in evaporite and terrigenous clastic deposition in semi-isolated subbasins. Preliminary paleogeographic maps of central Nova Scotia depict transgressive and regressive maxima for each of the three major cycles. Complex regional variation dictates caution in applying these models throughout Atlantic Canada.

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*Abstract of paper presented to the 9th International Congress of Carboniferous Stratigraphy and Geology, University of Illinois, Urbana, Illinois, May, 1979.

TIME AND STRATIGRAPHY IN THE WINDSOR GROUP OF NOVA SCOTIA*

P. S. Giles

Three major transgressive-regressive cycles can be recognized within the Middle to Late Visean Windsor Group in Nova Scotia. The first major cycle consists of rapid marine invasion followed by a period of regression due to basin filling, and is recorded by the sequence carbonate-anhydrite-halite-siltstone. Lateral equivalence of superadjacent rock units within this cycle can be demonstrated. Major cycles 2 and 3 are complex, and are typified by periodic marine invasions, each followed by arid tidal flat and continental sedimentation. Within major cycles 2 and 3 in southcentral Nova Scotia, at least 24 discrete marine transgressions are indicated. The thin carbonate members which record these events are lithologically distinct, laterally continuous and constitute excellent marker horizons. They represent distinct depositional events and can be used to establish approximate time lines within major cycles 2 and 3.

The boundaries of the major cycles coincide with points of major lithologic subdivisions. These same boundaries also equate with biostratigraphic boundaries confirmed by independent studies of shelly macrofauna, calcareous Foraminifera, conodonts and palynomorphs. These data suggest that the major cycles are bound by time planes, thereby establishing a useful framework for paleogeographic reconstruction.

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*Abstract of paper presented at 1978 joint meeting of Geological Association of Canada, Mineralogical Association of Canada and Geological Association of America, Toronto, Ontario, October, 1978.

NOTE ON REVISED STRATIGRAPHY OF THE LOWER CARBONIFEROUS WINDSOR GROUP, CRYSTAL CLIFFS SECTION, ANTIGONISH COUNTY, NOVA SCOTIA

R. C. Boehner

INTRODUCTION

The Crystal Cliffs section is a nearly continuously exposed section situated along the St. Georges Bay shoreline between Crystal Cliffs and MacIsaac Point, located approximately 13 km north of Antigonish (Figures 1 and 2). Crystal Cliffs Manor (Figure 2), which takes its name from the gypsum cliffs nearby, was the location of the Nova Scotia Centre for Geological Sciences which operated during the late 1940's to 1950's under the auspices of the Massachusettes Institute of Technology. Many undergraduate and graduate thesis studies were carried out in the immediate area. One of these studies was undertaken by Sage (1954) who described the stratigraphy of the Windsor Group in the Antigonish map area. The Crystal Cliffs section was considered by Sage (1954), to be one of the best sections showing the normal Windsor Group A Subzone sequence. Within this section Sage recognized a stratigraphic succession with the basal Windsor Group (A_1) limestone (variously referred to as ribbon, basal, sandy-limy or Macumber Formation) overlain by an uncertain thickness of gypsum, which contained a thin limestone referred to as the A_2 or Canary limestone.

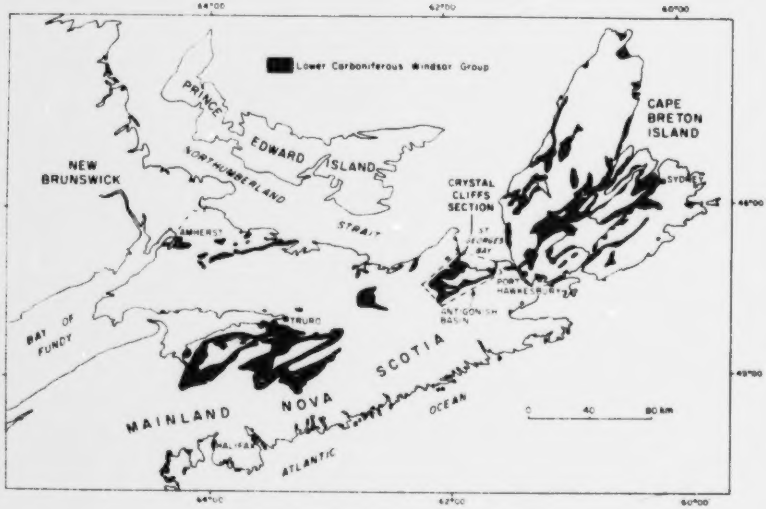

Figure 1. Location map of the Crystal Cliffs section.

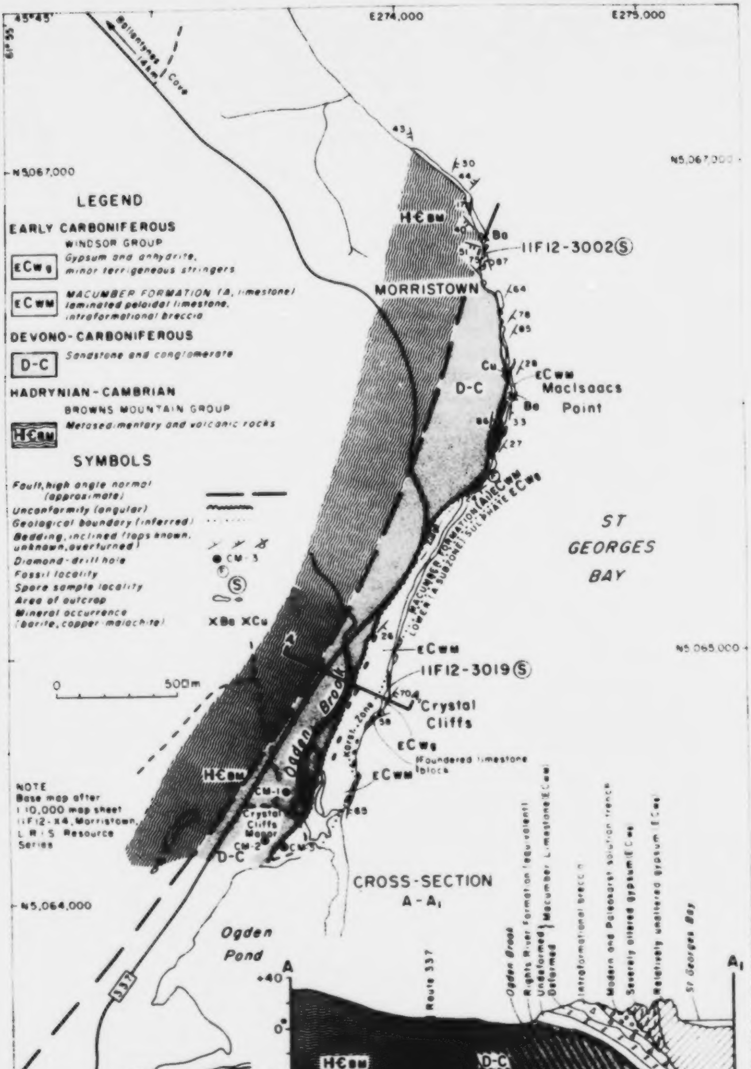
45°45'
61°55'
Ballantynes Cove 14 km
E274,000
E275,000
N5,067,000
N5,065,000
N5,064,000
LEGEND
EARLY CARBONIFEROUS
WINDSOR GROUP
ECwg
Gypsum and anhydrite, minor terrigeneous stringers
ECwm
MACUMBER FORMATION (A, limestone) laminated peloidal limestone, intraformational breccia
DEVONO-CARBONIFEROUS
D-C
Sandstone and conglomerate
HADRYNIAN-CAMBRIAN
BROWNS MOUNTAIN GROUP
HЄBM
Metasedimentary and volcanic rocks
SYMBOLS
Fault, high angle normal (approximate)
Unconformity (angular)
Geological boundary (inferred)
Bedding, inclined (tops known, unknown, overturned)
Diamond-drill hole
CM-3
Fossil locality
Spore sample locality
Area of outcrop
Mineral occurrence (barite, copper malachite)
XBa XCu
0
500m
NOTE
Base map after 1:10,000 map sheet 11F12-X4, Morristown, L.R.I.S. Resource Series
MORRISTOWN
11F12-3002(S)
Ba
Cu
ECwm
MacIsaacs Point
D-C
ST GEORGES BAY
MACUMBER FORMATION (A) ECwm
LOWER (A SUBZONE) SULPHATE ECwg
ECwm
11F12-3019(S)
Crystal Cliffs
Ogden Brook
Karst Zone
ECwg
(Foundered limestone block)
ECwm
HЄBM
CM-1
Crystal Cliffs Manor
CM-2
CM-3
D-C
CROSS-SECTION A-A1
Ogden Pond
337
JIMTOWN
Antigonish 16 km
61°55'
45°42'30"
A
A1
+40
0
-40
m
0
100
200
300
400
500
m
E274,000
E275,000
Datum mean sea level
Route 337
Ogden Brook
Rights River Formation (equivalent)
Undeformed
Deformed
Macumber Limestone (ECwm)
Intraformational breccia
Modern and Paleokarst solution trench
Severely altered gypsum (ECwg)
Relatively unaltered gypsum (ECwg)
St Georges Bay
HЄBM
D-C

Figure 2. Geological map of the Crystal Cliffs section.

The A_1 limestone was described as overlying, with angular unconformity, steeply dipping sandstone and conglomerate of the Horton Group (Horton Sandstone). Sage (1954) recognized that the section, in detail, was difficult to measure and describe accurately due to its along-strike configuration and because of extensive slumping and continuing shoreline erosion. A re-examination of the section indicates far more complexity than was previously realized.

STRATIGRAPHY

The Crystal Cliffs section is a strike section approximately 3 km long with successively younger rocks exposed from north to south (Figure 2). The oldest rocks comprise an unknown thickness of folded metasedimentary and volcanic rocks that have been intruded by mafic dykes. These strata are assigned to the Lower Paleozoic Browns Mountain Group of Benson (1970 and 1974) and are presumed to form the basement to the overlying Late Devonian-Carboniferous succession, although the contact is a fault in this section (Figure 2).

South of this faulted contact, a stratified succession of steeply dipping to overturned sandstone and conglomerate is well exposed at low water and is approximately 300 m thick. For the purposes of this note and until further mapping is carried out, these rocks have been tentatively assigned to an undivided Devono-Carboniferous unit in view of the new spore age data (see subsequent discussion) and the conclusions of Keppie, et al. (1978).

The steeply dipping Devono-Carboniferous rocks are overlain by moderately dipping younger rocks of Carboniferous age. The contact is a distinct angular unconformity that is well exposed at several localities where erosion has cut across the strike section (Figures 2 and 3). Typically, the contact is marked by a thin (1 to 3 m) green meta-siltstone pebble paraconglomerate which is developed immediately beneath the basal Windsor Group unit variously named the A_1 limestone (Sage, 1954) or Macumber Formation (Schenk, 1967). The conglomerate appears to infill depressions within the steeply dipping rocks beneath. No gradation with the Macumber Formation is detected and the contact is very sharp. However, the basal part of the Macumber is more argillaceous to arenaceous than the upper parts. This conglomerate may be a dramatically thinned facies of the Rights River Formation of Murray (1960) or the Wilkie Brook Formation of Keppie, et al. (1978), and may therefore be equivalent to parts of the Tournaisian Horton Group. Similarities with the rocks of the upper parts of these Formations are apparent and the correlation is favoured, but must be considered tentative until confirmed by more supportive data. It may be argued that the conglomerate represents the initial marginal marine deposits of the Windsor Group transgression as in the case of the basal breccias (with carbonate matrix) of the Gays River Formation (Giles, et al., 1979). Carbonate is virtually absent as matrix material in the conglomerate and no diagnostic evidence for a marine origin has been recognized. The conglomerate may have originated from the alteration and limited reworking of residual and locally derived material, by the transgressing Windsor sea. This situation is inferred to have occurred in the western part of the Antigonish Basin where the Gays River Formation

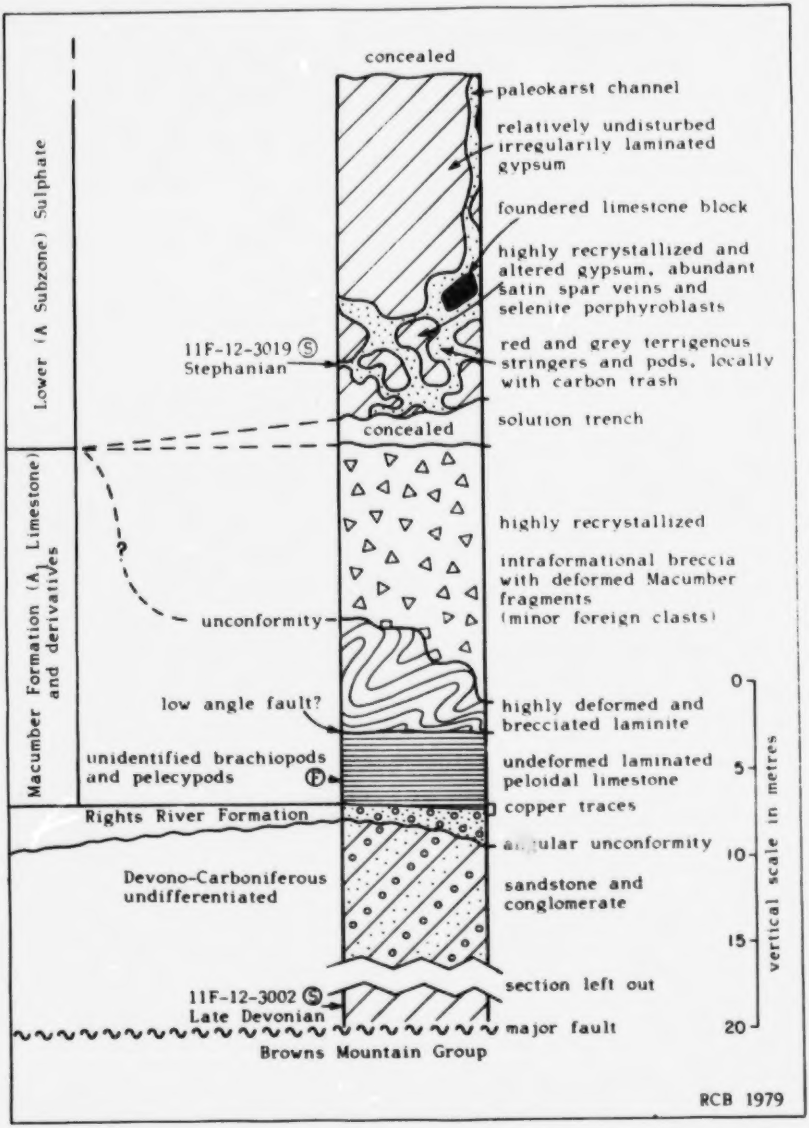
concealed
paleokarst channel
relatively undisturbed irregularily laminated gypsum
foundered limestone block
highly recrystallized and altered gypsum, abundant satin spar veins and selenite porphyroblasts
red and grey terrigenous stringers and pods, locally with carbon trash
solution trench
concealed
11F-12-3019 Ⓢ
Stephanian
Lower (A Subzone) Sulphate
Macumber Formation (A, Limestone) and derivatives
?
highly recrystallized
intraformational breccia with deformed Macumber fragments (minor foreign clasts)
unconformity
low angle fault?
highly deformed and brecciated laminite
unidentified brachiopods and pelecypods Ⓕ
undeformed laminated peloidal limestone
Rights River Formation
copper traces
angular unconformity
Devono-Carboniferous undifferentiated
sandstone and conglomerate
section left out
11F-12-3002 Ⓢ
Late Devonian
major fault
Browns Mountain Group
0
5
10
15
20
vertical scale in metres
RCB 1979

Figure 3. Schematic stratigraphic column of the Crystal Cliffs section.

overlies locally developed breccia with carbonate matrix or with terrigenous matrix. In the latter case, the unit is very similar to the upper part of the Rights River Formation. The conglomerate unit in the Crystal Cliffs section is too thin to form a mappable unit, and therefore no formal name is suggested.

For mapping purposes, the base of the overlying Macumber Formation (limestone) appears to be the natural lithologic break which defines the base of the Windsor Group. The name Macumber Formation was applied to the A_1 limestone in the area by Schenk (1967) who studied the unit at many locations in the Maritime Provinces. The Macumber Formation, where unaltered, is a distinctive well laminated, peloidal, fine grained, locally argillaceous to arenaceous limestone believed by Schenk (1967) to be dominantly of algal origin. In most areas, the Macumber Formation is very sparsely fossiliferous, although certain facies-equivalents such as the Gays River Formation (Giles, et al., 1979) may have an abundant fauna and flora. The Macumber Formation at McIsaac Point (Figure 2) locally has poorly preserved smooth shelled brachiopods *(Beecheria?)* and unidentified pelecypods on bedding surfaces. In the Crystal Cliffs section, the upper part of the Macumber Formation has been highly disturbed structurally and extensively altered through recrystallization. The typical undisturbed Macumber lithology occurs only for a few metres above the conglomerate at the unconformity. Sharp breaks in the section, interpreted as low angle bedding plane faults, separate the overlying highly deformed and brecciated laminite rock from the undeformed equivalents beneath. This deformed unit is structurally thickened by tight folds with recumbent isoclinal geometry.

The deformed laminite is overlain and truncated by intraformational breccia comprising variably recrystallized limestone fragments in the pebble to cobble size range. The intraformational breccia is exposed in nearly continuous strike section as far south along the shore as the gypsum at Crystal Cliffs. The unit is relatively resistant to erosion and forms a prominent "hogs back" ridge between the shore highway and the shoreline. Foreign pebbles of metamorphic and igneous provenance are a minor component. The breccia clasts display varying degrees of rounding and range from in situ infilled brecciated laminite to transported well rounded, vaguely stratified lenses.

Gypsum, probably correlative with the Carrolls Corner Formation (Giles and Boehner, 1979), overlies the intraformational breccia at Crystal Cliffs. The gypsum, in which stratification is not well developed, is typically very highly recrystallized (coarsely selenitic) with fractures infilled by orange to white coloured satinspar veins and grey green to red terrigenous material, particularly near the contact with the intraformational (limestone) breccia. A large proportion of grey and red siltstone and sandstone as irregular stringers and pods in the gypsum is present in the highly altered contact zone at the base of the gypsum. Carbonaceous to coaly material and pyritic selenite (black) are present as undeformed fragments and inclusions in the grey siltstone. Palynomorphs have been successfully extracted from these siltstones (Sample No. 11F12-3019S).

Within the gypsum section at the extreme southern end of the section the A_2 or Canary limestone was reported by Sage (1954). The present section does not appear to clearly support the occurrence of a separate limestone unit and the previously reported A_2 limestone is reinterpreted as the intraformational breccia at the top of the Macumber Formation. Outcrop and subsurface data from the Antigonish Basin yield no clear supportive evidence for the occurrence of a laterally extensive major carbonate unit at the A_2 level, within the lower (A subzone) sulphate. Specific localities cited as the A_2 limestone, have been shown to represent other carbonate members. For example, Giles (this report) has collected rugose coral specimens from a locality reported as A_2 limestone on the Pomquet River (Sage, 1954) and correlates this unit with the uppermost E_1 limestone of Sage (1954) on both faunal and lithological grounds.

Limestone is definitely present in the gypsum at Crystal Cliffs however, approximately 300 m north of Sage's (1954) A_2 locality. This limestone occurs as a large (5 m) block with associated red and grey shale within the highly altered and disturbed zone near the base of the gypsum unit (Figure 3). The orientation of the block is totally discordant with the enclosing beds and it is interpreted as a foundered block in a highly disturbed karstic solution trench. The original stratigraphic position of the block is uncertain.

The stratigraphic succession of the Windsor Group exposed in the Crystal Cliffs section consists, in summary, of the Macumber Formation and deformed equivalents, an intraformational breccia, and a highly disturbed gypsum unit, all of which are assigned to the Lower Windsor.

PALYNOLOGY

The spore assemblage (Table 1) extracted at locality 11F12-3004S is considered by Barss (personal communication, 1979) to be correlative with a Late Devonian assemblage from McInnis Brook at Cape George. This is considered equivalent to the PL zone of Clayton, et al. (1977). Thus the rocks at Crystal Cliffs are assigned to undivided Devono-Carboniferous although it is most probable that they are entirely Late Devonian.

Sampling of the terrigenous material within the gypsum at Crystal Cliffs (Figure 3, Table 1) produced unexpected results. Palynomorphs extracted from the inclusions within the gypsum are considered by Barss (personal communication, 1979) to be correlative with uppermost Carboniferous Stephanian assemblages. This locality was resampled in order to confirm the occurrence of Stephanian forms.

DISCUSSION

The incongruous occurrence of these forms within evaporites of the Early Carboniferous (Visean) Windsor Group requires explanation. Examination of the section clearly indicates that alteration and karstification are locally severe. Contamination by Stephanian age sediment, as paleokarst deposits, appears to be the most probable explanation, as opposed to reinterpreting the evaporite unit as an Upper Carboniferous formation. Introduction by faulting is not considered likely because of

Table 1. Palynomorphs recovered from Crystal Cliffs section, sample numbers 11F12-3002S and 11F12-3019S (location see Figure 2); identification and age assignment by M. S. Barss, Geological Survey of Canada (personal communication, 1979).

NSDME Sample Number: 11F12-3002S
GSC Locality Number: D1726
GSC Preparation Number: P14715

Assignment: Numerous spores present. Assemblage correlates with the *Vallatisporites pusillites - Spelaeotriletes lepidophytus* (PL) Zone of Western Europe (Clayton, et al., 1977). This assemblage is similar to the assemblage recovered from the McInnis Brook section near Cape George to the north of the area.

NSDME Sample Number: 11F12-3019S
GSC Locality Number: D1727
GSC Preparation Number: P14718

Assignment: Very well preserved spores present. The assemblage is characterized by having numerous saccate spores (possibly Stephanian). Locality resampled to confirm tentative Stephanian assignment.

GSC Locality Number: D1727
GSC Preparation Numbers: P16890 and P16891

Assignment: The assemblage recovered can be assigned to the *Potonieisporites* Zone of Barss, et al. (1979) confirming the initial Stephanian assignment.

the undeformed nature of the incompetent terrigenous infilling. The section is highly disturbed and evidently has had a long history of exposure, subaerial erosion and karstification. These processes may have been initiated in Visean time shortly after deposition of the Macumber Formation and may have been related, as proposed by Schenk (1967), to locallized horst uplift. Low angle faulting and deformation preceded and may have been, in part, contemporaneous with the development of the intraformational breccia.

The initial karstification may have occurred, alternatively, during the Stephanian. It is presently continuing as evidenced by slumping and subsiding due to dissolution by ground water. This process is most active at the intraformational breccia-gypsum contact were a solution trench is well developed. The extent of the solution trench and other karstic features downdip is not known. In any event, the development of the karst features is not entirely a recent phenomenon. In fact, the present configuration may be a rejuvenation and modification of a multiple generation karst system.

Assignment of certain features to karst origin, as opposed to structural, is not clear-cut, as karst processes may obscure or destroy diagnostic features of pre-existing faulting. Difficulties arise in determining the chronologic sequence of events, especially when faulting and tectonic movement of the evaporite rocks into the section are considered. The complete history of the section is not clear at this time, but the recognition of the complexities is important in understanding the local and regional depositional, structural and paleogeographic setting of the Windsor Group (see Giles, this report).

ACKNOWLEDGMENTS

Sincere thanks are extended to M. S. Barss of the Geological Survey of Canada who kindly performed the palynological identification and age assignments which form part of the rationale for reinterpreting and revising the stratigraphy of the section. However, responsibility for these revisions rests entirely with the author. Assistance in the field work aspect of this investigation was ably provided by M. Savell.

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PRELIMINARY REPORT ON THE CARBONIFEROUS GEOLOGY OF THE ANTIGONISH STRUCTURAL BASIN, ANTIGONISH COUNTY, NOVA SCOTIA

R. C. Boehner

INTRODUCTION

The Antigonish Structural Basin (Figure 1) underlies an area of approximately 600 km^2 in Antigonish County, northeastern mainland Nova Scotia. The principal objective of this study is to map and describe in more detail the Windsor Group strata in the area (Figures 2 and 3) with emphasis on determining their stratigaphic succession, structure and paleogeography.

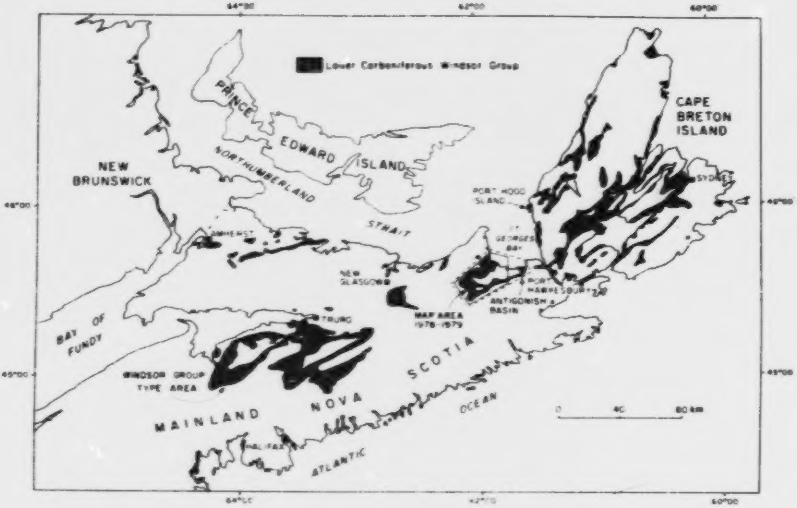


Figure 1. Location map of the Antigonish Basin.

Field mapping with emphasis on the Windsor Group and to a more limited extent older and younger rocks of the Antigonish Structural Basin on parts of NTS map sheets 11F12W, 11E8, 11E9 and 11F5W was completed during the summers of 1978 and 1979. Final report and map preparation will follow. Data recorded were compiled on orthophotographic maps produced by the Land Registration and Information Service (LRIS, Council of Maritime Premiers) at a scale of 1:10,000. Data were reduced to a base map at a scale of 1:50,000 and a simplified version is presented in Figure 2. All diamond-drill core currently available was logged and, although the number of holes is relatively small and their distribution is clustered, they are of great value, in most instances for positioning major contacts. Drilling by private exploration concerns provided the subsurface data available for the area.

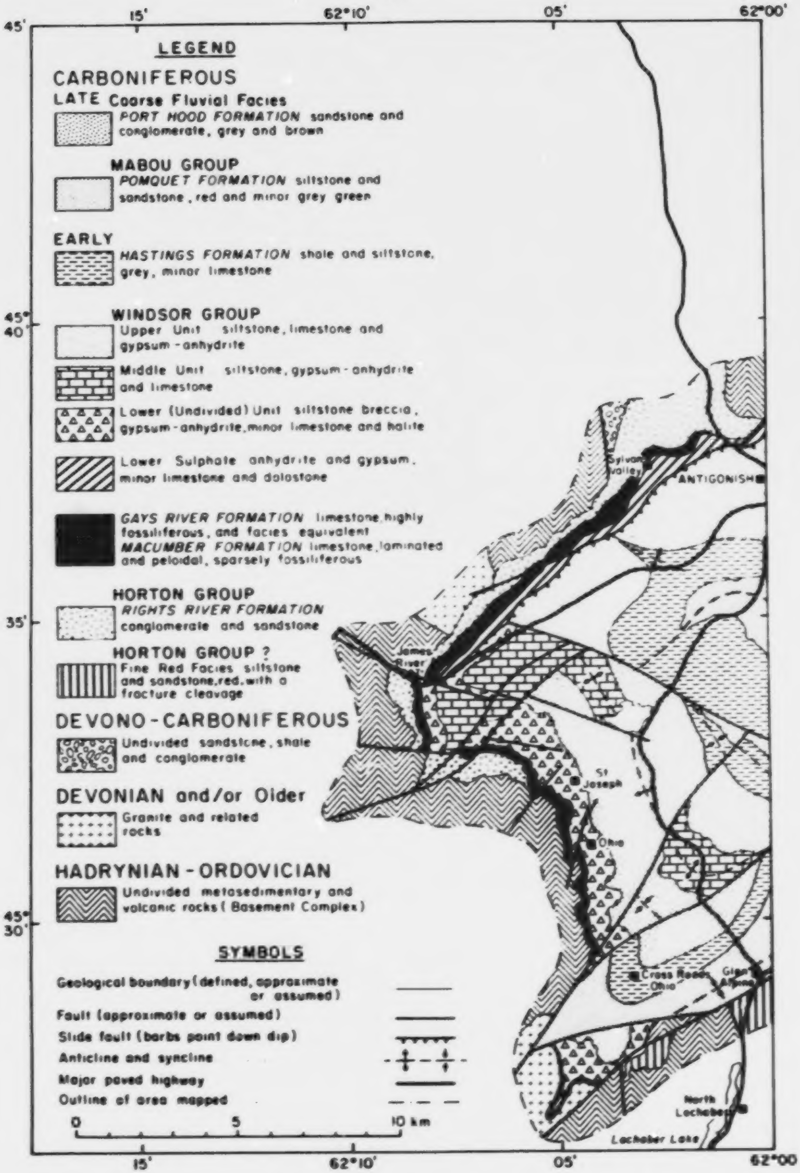

15'
62°10'
05'
62°00'
45'
45° 40'
35'
45° 30'
LEGEND
CARBONIFEROUS
LATE Coarse Fluvial Facies
PORT HOOD FORMATION sandstone and conglomerate, grey and brown
MABOU GROUP
POMQUET FORMATION siltstone and sandstone, red and minor grey green
EARLY
HASTINGS FORMATION shale and siltstone, grey, minor limestone
WINDSOR GROUP
Upper Unit siltstone, limestone and gypsum - anhydrite
Middle Unit siltstone, gypsum - anhydrite and limestone
Lower (Undivided) Unit siltstone breccia, gypsum - anhydrite, minor limestone and halite
Lower Sulphate anhydrite and gypsum, minor limestone and dolostone
GAYS RIVER FORMATION limestone, highly fossiliferous, and facies equivalent
MACUMBER FORMATION limestone, laminated and peloidal, sparsely fossiliferous
HORTON GROUP
RIGHTS RIVER FORMATION conglomerate and sandstone
HORTON GROUP ?
Fine Red Facies siltstone and sandstone, red, with a fracture cleavage
DEVONO - CARBONIFEROUS
Undivided sandstone, shale and conglomerate
DEVONIAN and/or Older
Granite and related rocks
HADRYNIAN - ORDOVICIAN
Undivided metasedimentary and volcanic rocks (Basement Complex)
SYMBOLS
Geological boundary (defined, approximate or assumed)
Fault (approximate or assumed)
Slide fault (barbs point down dip)
Anticline and syncline
Major paved highway
Outline of area mapped
0
5
10 km
Sylvan Valley
ANTIGONISH
James River
St Joseph
Ohio
Cross Roads Ohio
Glen Alpine
North Lochaber
Lochaber Lake
15'
62°10'
05'
62°00'

Figure 2. Preliminary geological map of the Antigonish Basin.

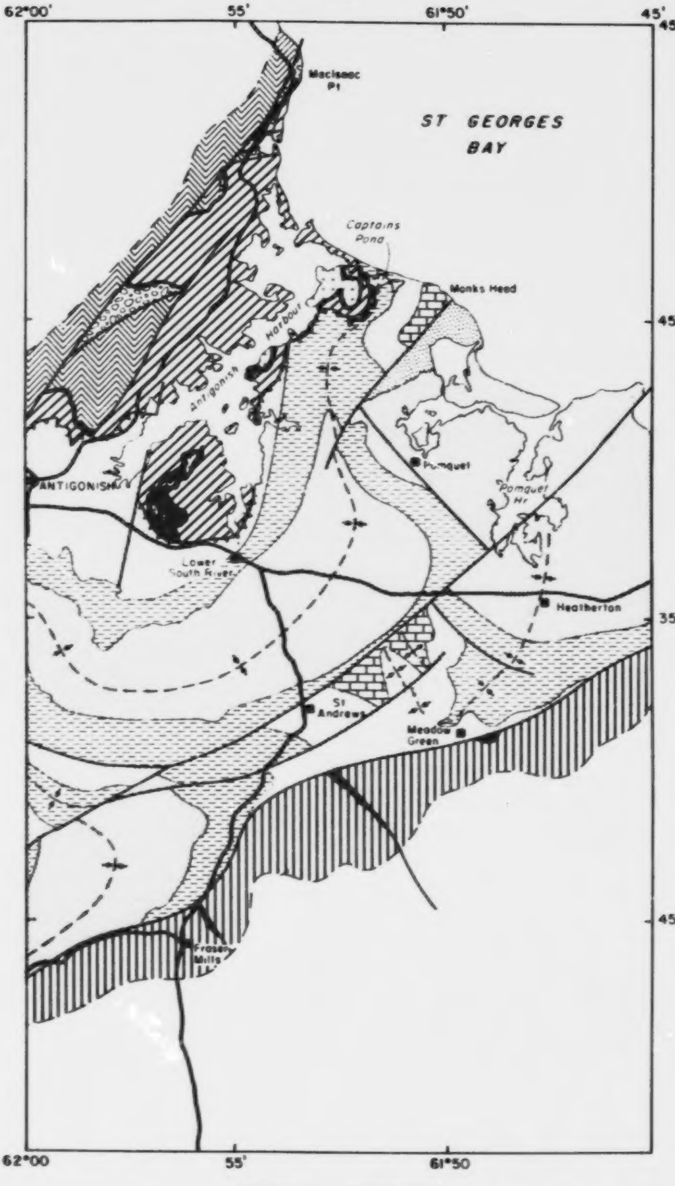


Figure 2. Continued

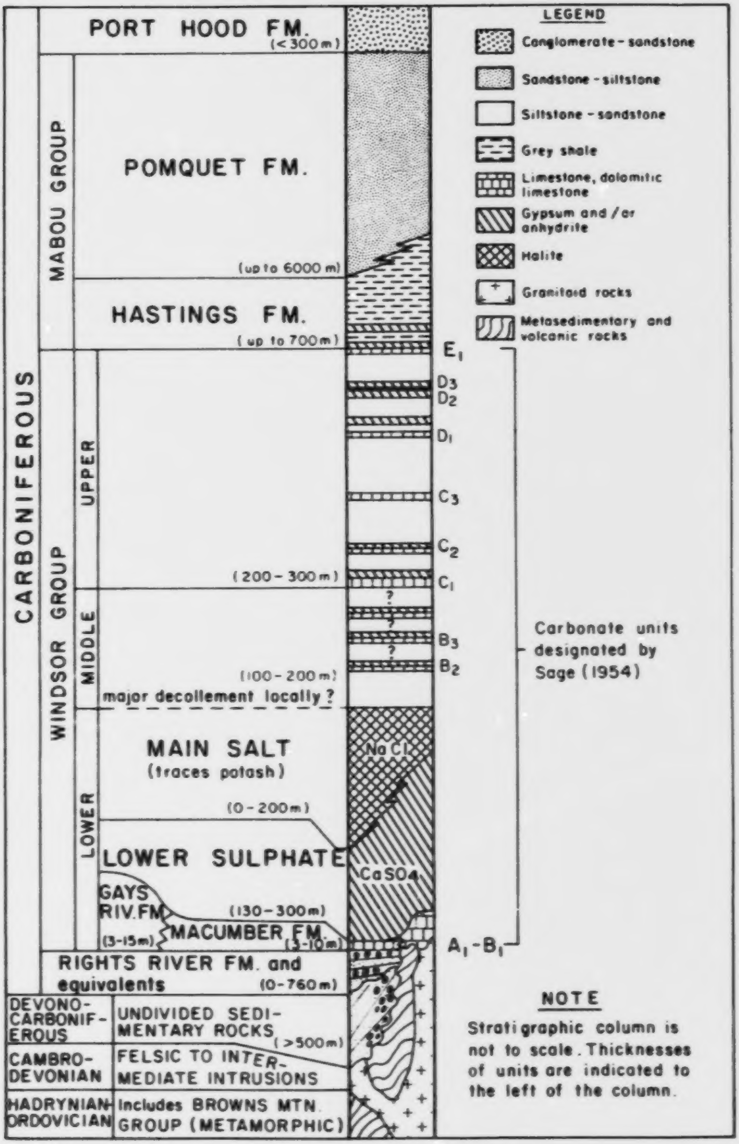


Figure 3. Preliminary stratigraphic column for the Antigonish Basin.

The Antigonish Basin has been explored sporadically for industrial minerals, petroleum and base metal deposits over the past 100 years. The general geology in the Antigonish area was first described and mapped by Fletcher (1892, 1887). More detailed, specific studies of the Windsor Group, were carried out by Hayes and Pohl (1931) and most importantly by Sage (1954), who described the Windsor Group stratigraphy and paleontology of the Antigonish quadrangles (11F12). Many unpublished studies of the geology in the area were undertaken in the late 1940's to late 1950's by students who attended the Nova Scotia Centre of Geological Sciences at Crystal Cliffs. Schenk (1969) made a detailed petrologic study of the Windsor Group carbonate-sulphate-redbed facies in parts of the area.

The stratigraphy of the Carboniferous rocks in the central part of the Antigonish Basin was described by Belt (1964, 1965) as part of a regional study of Middle Carboniferous rocks. Revisions of Middle and Upper Carboniferous nomenclature were proposed and these revisions are used where appropriate in this study. The latest published geological maps for the area were produced by Benson (1974 and 1970).

GENERAL GEOLOGICAL SETTING

Carboniferous rocks (Table 1) described in this report define the Antigonish Structural Basin which occupies the southern part of the Antigonish (depositional) area of Bell (1958). This is a portion of the larger Carboniferous Basin in Atlantic Canada also called the Fundy Epieugeosyncline (Kelley, 1970), Fundy Basin (Belt, 1968) or Fundy Aulacogene (Keppie, 1977). This elongate Basin developed during the Late Devonian and was active throughout the Carboniferous as a system of fault block (rift) and down-warped intermontane basins upon the folded Acadian Orogen (Belt, 1968). A great thickness of terrigenous sediment accumulated in the deeper parts, especially in the central mobile area where thicknesses up to 10,000 m are reported (Howie and Barss, 1975). Belt (1965) indicated more than 6000 m of post-Windsor Group strata in the deeper parts of the Antigonish Basin. In this area, a Windsor Group thickness of 1000 m is probable and an equal minimum thickness would be expected for the Horton Group. The basin therefore contains a very thick stratigraphic section, an outline of which is presented in later paragraphs.

The Carboniferous Basin is bordered on the west and north by the Antigonish Highlands Massif (Figure 4), which comprises variably deformed and metamorphosed sediments and volcanic rocks assigned to the Cambro-Ordovician Browns Mountain Group by Benson (1974) and granitoid intrusives assigned to the Ordovician and Devonian. In the present study these rocks were not generally subdivided, and were considered in simplistic terms as the basement to the Carboniferous succession.

The southeastern and southern border of the Antigonish Basin is defined by a broad folded belt of sedimentary strata assigned tentatively to the Horton Group. These rocks, with a small thickness of concordant Lower Windsor strata, are believed to be separated from the Antigonish Basin proper by a major northeasterly trending fault extending the entire length of the map area (Figure 2).

Table 1. Summary of Antigonish Basin stratigraphic nomenclature with approximate age correlation. Conformable section (stated, inferred)—— - - -; Unconformity ∿; Facies boundary ϟ ; Contact relations unspecified and uncertain ? .

	ERA	PALEOZOIC						
	PERIOD OR EPOCH	PRE-DEVONIAN	DEVONIAN	EARLY CARBONIFEROUS		LATE CARBONIFEROUS		
				MISSISSIPPIAN			PENNSYLVANIAN	
	EUROPEAN STAGES		FAMENIAN	TOURNAISIAN	VISEAN	NAMURIAN	WESTPHALIAN	STEPHANIAN
Fletcher and Faribault (1887-1892)	GROUP	Browns Mtn	Devonian (Sedimentary)	Carboniferous Conglomerate	Carboniferous Limestone			
	FORMATION	Precamb, Camb-Silurian, ign intr	undivided	undivided	undivided			
Sage (1954)	GROUP	Browns Mtn (ORD)	Igneous intrusives Pre-Miss	Horton	Windsor	Canso	Riversdale, Cumberland and Pictou	
	FORMATION	undivided		northern alluvial and southern fine gr facies	A₁ to E₁ limestones (subzones A to E)	undivided	undivided	
Bell (1958)	GROUP	Pre-Carboniferous		Horton	Windsor	Canso	Riversdale	
	FORMATION	not studied		undivided	? subdivisions of Sage (1954)	? undivided	? undivided	
Murray (1960)	GROUP	Pre-Carboniferous		Horton	Windsor			
	FORMATION	not studied		Sou Lk Ck Cape Geo Rights Riv Wk Bk	subdivisions of Sage (1954)	? Lismore and Cribbean Head		
	MEMBER	undivided		Big Mar Gm Bk	undivided (internal unconformities)			
Bell (1965)	GROUP	not studied			Windsor	Mabou	Coarse Fluvial Facies	
	FORMATION				undivided	Hastings Pomquet	Port Hood	
Benson (1970)	GROUP	Ordovician-Silurian and older		Horton	Windsor	Canso (Mabou)		
	FORMATION	Devonian intrusives		several unnamed map units	undivided	? undivided Pomquet ?	Port Hood	
Benson (1975)	GROUP	numerous groups and		Horton	Windsor	Canso	Cumberland and Pictou	
	FORMATION	formations, Cambro-Devonian		Rights River	undivided	undivided ?	undivided	
This Study	GROUP	Precambrian-Early Devonian	Upper Devonian undivided	Horton	Windsor	Mabou	Coarse Fluvial Facies	
	FORMATION	undiv sedimentary and igneous rocks ?	may incl South Lake Ck (Murray, 1960)	Rights River	Lower A Middle B Upper C-E	Hastings Pomquet	Port Hood	

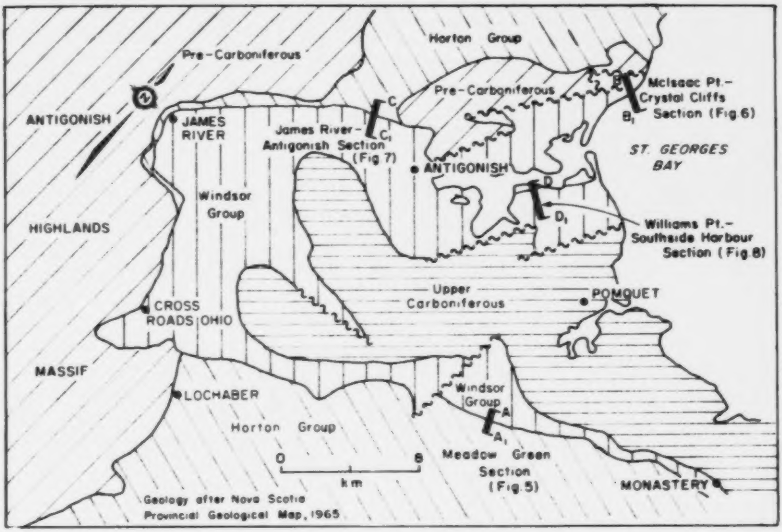


Figure 4. Location map for schematic cross-sections in the lower part of the Windsor Group.

CARBONIFEROUS STRATIGRAPHY

Horton Group

The Horton Group, in present usage, is a name applied to all post-Acadian and pre-Windsor Group terrigenous sedimentary rocks that initially were considered to be entirely Carboniferous in age, but have also been shown to include Upper and even Middle Devonian strata (Howie and Barss, 1975; Benson, 1970, 1974) (Table 1, Figure 3). Since this study concentrated on the Windsor Group, and the Horton Group outcrop areas within the map area are limited, clarification of Horton Group stratigraphic problems outlined by Keppie, et al. (1978) was not possible.

The Horton Group stratigraphy in the Antigonish Basin and surrounding areas was first studied in detail by Murray (1960) who named and defined several rock stratigraphic units. These units have not generally been applied formally by subsequent workers. However, Benson (1974) applied and extended the Rights River Formation name to include all rocks previously subdivided by Murray (1960).

Outcrop areas, of uncertain stratigraphic relations and age and with lithology similar to that described by previous workers for Horton Group strata, were assigned to an undivided Devono-Carboniferous map unit. These rocks which are recognized in the Sylvan Valley, near Crystal Cliffs (see Boehner this volume) and in small areas north of Antigonish, may or may not be assignable to previous workers stratigraphic schemes.

The Horton section comprises a sequence of red and grey-green sandstone conglomerate and shale. The best-exposed section of Horton Group, according to Murray (1960) and Sage (1954), occurs in Ogden Brook, west of Crystal Cliffs. At this locality, thicknesses of 670 m (2200') of basal conglomerate (Ogden Brook Formation) and 1585 m (5200') of "Upper" Horton, comprising interbedded sandstone conglomerate (part of the South Lake Creek Formation), were measured above the angular unconformity with the Browns Mountain Group. Additional younger units (Table 1) were described from the Big Marsh and Cape George areas.

In the present map area the uppermost Horton unit of Murray (1960), named the Rights River Formation, occurs abundantly in outcrop. The Rights River Formation has its type section along the Rights River and comprises up to 760 m (2500') of interbedded conglomerate and sandstone.

The Rights River Formation (Murray, 1960) is well exposed along the Basin margin between James River and Antigonish (Figure 2). The base is a distinct angular unconformity with undivided pre-Carboniferous rock. The conglomerate typically is red with minor green and a variety of igneous and metasedimentary rock clasts. The clasts are poorly sorted and angular to subangular. The sandstone interbedded with the conglomerate is red with minor green and is variably conglomeratic. The upper part of the section is characterized by a variable thickness of unstratified to weakly stratified green polymictic conglomerate. In all instances the unit is overlain concordantly by basal Windsor Group Macumber Formation. In areas of thinning and pinchout the green polymictic conglomerate may be the only representative facies of the Rights River Formation. This situation is believed to occur at Crystal Cliffs (see Boehner this volume) where it may be represented by as little as 1 to 2 m of poorly sorted angular breccia.

In the Beaver River region there is an outcrop area of coarse polymictic boulder-cobble conglomerate which is lithologically similar to the Ogden Brook Formation (Murray, 1960). This outcrop area is included within the Rights River Formation, although contacts with younger rocks are not exposed. This correlation is tentative until further examination of the Horton Group is made. Near St. Josephs Lake, the Macumber Formation and/or Gays River Formation concordantly overlie a thin section of terrigenous strata similar to the Rights River Formation.

Along the southern border of the Basin, rocks tentatively assigned to the Horton Group comprise folded relatively competent interbedded red siltstone and sandstone with fracture cleavage variably developed. In this area the Group is concordantly and conformably (?) overlain by the Macumber Formation. The age of the Horton Group may range from the Devonian to the Carboniferous, and revision will no doubt be necessary with more rigorous study in the future.

Windsor Group

The basic stratigraphic section of the Windsor Group in the Antigonish Basin was outlined by Sage (1954) who placed emphasis upon the megafauna in assignment and correlation of the carbonate units. The alphanumeric system of faunal subzone letter designations with ascending numerical subscripts created by Stacey (1953) were used by Sage (1954) (Table 2).

The stratigraphic section described by Sage (1954) was derived by comparing small, structurally complex broken sections with the well exposed Port Hood Island section and the Windsor type section. Sage (1954) cited the Monks Head and Pomquet River sections as being most complete with respect to the number of limestone marker horizons present. He stated that in both cases the intervals between limestone units are impossible to determine due to complex structure. According to Sage (1954), approximately one-half of the Pomquet River section is overturned and the Monks Head section is "shuffled like a pack of cards". The complexity of these sections was confirmed in the present study.

The majority of Sage's (1954) carbonate unit assignments in the area have been confirmed although certain sections and units including the Milk Plant and Pomquet River sections and the A_2 or Canary limestone have been reinterpreted. The scarcity of well exposed stratigraphic sections severely hinders the mapping of many of the thin individual carbonate units. Of all the carbonate units, the C_1 and E_1 and equivalents are the best units for mapping purposes.

Table 2
Limestone units recognized in the Antigonish Basin (Sage, 1954)
(see also Figure 3)

Subzone (Bell 1929)	Name
E	E_1 or Schizodus
D	D_3 No Name
	D_2 No Name
	D_1 or Giant Ripple
C	C_3 or Columnar Algal
	C_2 No Name
	C_1 or Small Algal
B	B_3 or 1st Oolitic
	B_2 or 2nd Oolitic
	B_1 or Quarry
A	A_2 or Canary
	A_1 or Basal, or Ribbon

The base of the Windsor Group in the Antigonish Basin is marked by a relatively thin carbonate unit (Figure 3) with varied lithology depending upon the area considered. In areas where the Windsor Group overlies the Horton Group, either concordantly or with angular unconformity, the finely laminated, peloidal-micritic Macumber Formation (A_1 limestone) is usually developed (Figures 4, 5, 6 and 7). The Macumber Formation is generally less than a few metres thick, but may exceed 10 m in some localities.

In areas where the basal Windsor Group oversteps the Horton Group to rest directly upon the pre-Carboniferous basement, the more areally extensive Macumber Formation undergoes facies change to the Gays River Formation (Giles, et al., 1979). Abundantly fossiliferous organic banks of this Formation are developed as at Williams Point-Southside Harbour (B_1 or Quarry Limestone of Sage, 1954) and near Ohio (Figures 2 and 8). The basal Windsor Group limestone or dolostone, regardless of facies, is generally overlain by a thick anhydrite unit informally referred to as the Lower Sulphate. Thickness may exceed 300 m or be as little as 130 m.

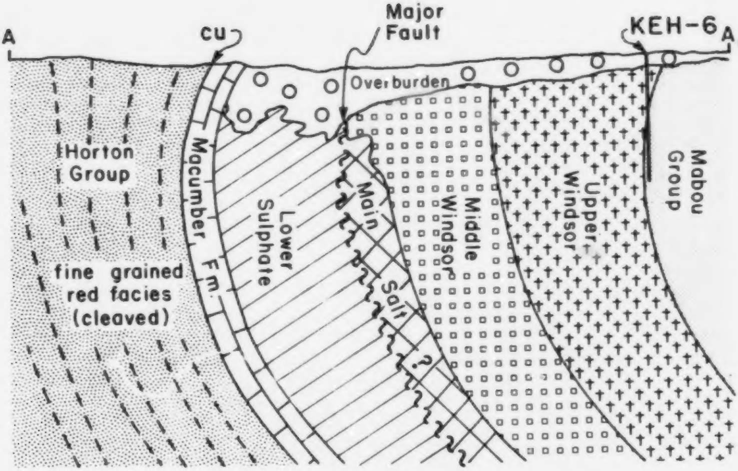


Figure 5. Schematic cross-section at Meadow Green (see Figure 4 for location).

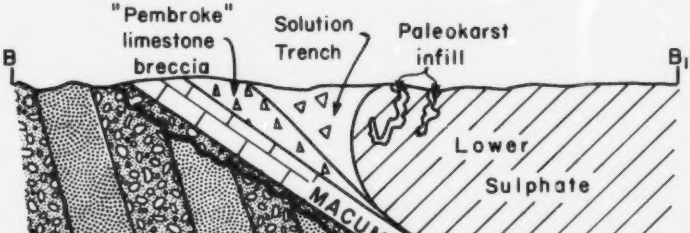


Figure 6. Schematic cross-section at Crystal Cliffs-McIsaac Point (see Figure 4 for location).

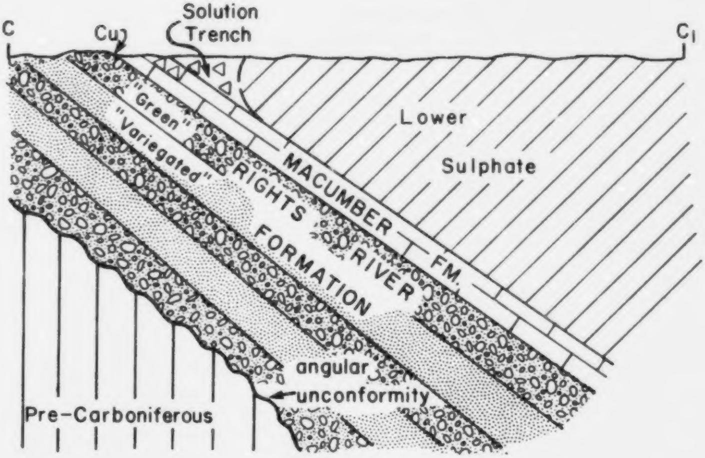


Figure 7. Schematic cross-section at James River-Antigonish (see Figure 4 for location).

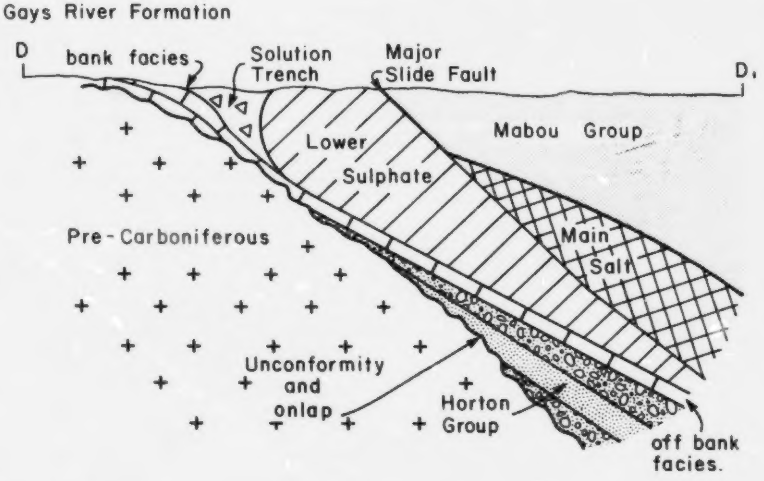


Figure 8. Schematic cross-section at Williams Point-Southside Harbour (see Figure 4 for location).

A thick unit of halite with intercalated anhydrite and terrigenous interbeds overlies the thick lower sulphate in the Southside Harbour area and near James River. This unit is informally referred to as the Main Salt and is probably correlative with the Stewiacke Formation of Giles, et al., (1979). In the Southside Harbour area, a major structural break is postulated near the top of the Main Salt or Lower Sulphate (Figures 2 and 8). In this area, uppermost Windsor and younger siltstone and shales overlie the Main Salt or the Lower Sulphate. The middle and upper Windsor Group map units are anomalously absent. Along strike and up-dip, however, some of these lower map units are recognized in close proximity and in typical lithology. Therefore a structural break is inferred to explain their absence.

The middle part of the Windsor Group above the Lower Sulphate and/or Main Salt is not well known from outcrop or subsurface data available in the Basin. An intercalated evaporite-carbonate-siltstone section typical of the evaporitic mid-Windsor in the Shubenacadie Basin is not common, but may be present in diamond-drill hole JR-3 near James River. In this study, the Middle Windsor, as a map unit, is outlined at its base by the top of the Lower Sulphate unit and at its top by the base of the Herbert River Limestone Member or C_1 limestone which marks the base of the Upper Windsor. Although defined in this way by bounding, mappable horizons, the middle Windsor map unit is not itself well understood at this time in the Antigonish Basin.

In the western part of the Basin, probable middle Windsor strata comprise a complex succession of reworked red and green siltstone breccia, and fossiliferous limestone and gypsum. This forms an informal lower map unit (Figure 2) known only from limited subsurface data in which core recovery was generally very poor. The potential regional significance of this type of deposition is discussed by Giles (this report).

The upper part of the Windsor Group is relatively well-defined, both in outcrop and in the subsurface. The base of the map unit is placed at the base of the distinctive Herbert River Limestone Member (Moore, 1967) or the laterally equivalent C_1 limestone of Sage (1954). The top of the map unit, which also coincides with the top of the Windsor Group as here defined, is placed at the top of the distinctive E_1 limestone of Sage (1954) or its facies equivalent. These units undergo lateral change between the type area (Windsor) facies and the Port Hood Island facies, probably in the southwestern parts of the Antigonish Basin. Thickness of the upper Windsor map unit may exceed 400 m. The contact with the overlying shales and sandstones with minor evaporites of the Mabou Group appears to be conformable and transitional.

The Mabou Group of Belt (1964, 1965) is a nonmarine terrigenous fluvio-lacustrine succession which overlies the uppermost marine strata of the Windsor Group in the eastern and central parts of the Antigonish Basin. The Mabou Group coincides approximately with the fine grained facies of the Canso and Riversdale Groups of Bell (1958), and comprises the Hastings and Pomquet Formations in ascending order. The Hastings Formation is typified by grey shales, many of which contain thin beds of buff weathered dolostone and dolomite mudstone. Minor thin red sandstone beds are commonly intercalated with the grey shale units. Gypsum is a minor constituent in the lowermost parts of the Hastings Formation. A thickness of approximately

700 m of Hastings Formation rocks outcrop in the Pomquet River. This section is overlain conformably by a thickness of up to 6000 m of Pomquet Formation which comprises red siltstone and shale with thin sandstone interbeds. The Visean-Namurian boundary occurs beneath the Hastings-Pomquet boundary making the Pomquet entirely Namurian in age (Neves and Belt, 1970).

According to Belt (1965) the Mabou Group is overlain and in part laterally equivalent to his Coarse Fluvial Facies unit. In the Antigonish Basin this unit is named the Port Hood Formation and comprises brownish-grey coarse grained sandstone. Stratigraphic sections are not well exposed. Belt (1965) indicated an estimated thickness of less than 300 m for the Port Hood Formation.

MAJOR STRUCTURE

The Antigonish Basin (Figure 2) is bound on its northwestern and southeastern borders by major high angle faults, and is defined as a graben. The major faults along the northwestern border extend from Crystal Cliffs-McIsaac Point in the northeast to the Beaver River area in the southwest (Figure 2). The faults are best defined at the extremities. A series of small transverse faults are offset by the major longitudinal faults producing a map pattern of small faultbound blocks and slices. Post Windsor Group movement along the longitudinal faults is mainly dip slip with minor strike slip.

The southeast border of the Basin is marked by a major longitudinal fault which completes the basic graben configuration. This fault extends northeasterly from the upper reaches of the Ohio River to the eastern edge of the map area near Heatherton. The magnitude of dip slip movement is apparently much greater than on the northwestern border faults. The Horton Group along the southeastern border is well indurated, folded and has a well developed fracture cleavage. The intensity of deformation within these rocks is much greater than in those mapped along the northwestern border. The southeastern border fault juxtaposes Upper Windsor Group and Mabou Group strata with Horton Group and thin slices of Macumber Formation. The Macumber Formation is preserved only as thin outcrop slices adjacent to transverse faults with northerly and northwesterly trends. These outcrop areas are severely shattered and deformed. At one exposure near Glen Alpine, a mafic sill or dyke intrudes the Macumber Formation.

The pattern of faulting along the northwestern border is complicated by a later, low angle slide fault which brings a large allochthonous block of middle to upper Windsor and younger rocks (Figure 2) in contact with older basal Windsor Group evaporite rocks. These evaporites, including the Lower Sulphate and Main Salt, are inferred to have provided the decollement surface. This slide fault extends from Antigonish Harbour to near James River. The strata above the slide fault define a doubly plunging syncline with a curvilinear axial trace. The western boundary of the allochthonous block is marked by a normal fault. This fault and the north-south trending folds to the west are truncated by a major longitudinal fault which parallels the southeastern border fault.

MINERAL EXPLORATION POTENTIAL

The Antigonish Basin, in particular the rocks of the Windsor Group, has been explored sporadically for base metal and other mineral deposits since the early 1900's. Mineral exploration has been most intense in the basal part of the Windsor Group where mineral occurrences are numerous (Table 3, Figure 9).

Copper minerals, principally malachite, chalcopyrite, azurite and chalcocite are found consistently in trace to minor amounts near the Macumber Formation-Horton Group or Gays River Formation-basement contact (Figures 2 and 9). In outcrop, this type of occurrence is well represented between Antigonish, James River and Ohio. Calcite veins, with or without barite, are locally present in the Macumber Formation or laterally equivalent rocks. Along the southeastern border of the Basin, the Macumber Formation concordantly overlies a red fine grained facies of the Horton Group (Figure 9). Copper is less abundant at the contact, but calcite veins cutting the Macumber commonly contain dolomite, variable fluorite, and less commonly, chalcopyrite and rare galena and sphalerite.

The limestone mounds developed on the northeasterly trending granitoid basement ridge in the Williams Point-Southside Harbour area are interesting as potential base metal hosts in that they are similar to the Gays River Formation mound at Gays River (Giles, et al., 1979). Traces of chalcopyrite, galena and barite have been recorded locally. These banks differ from the Gays River bank mainly in that they are composed of high calcium limestone as opposed to ubiquitous dolostone at Gays River. Buried carbonate banks may occur at depth along the extended trend to the southwest (Figure 2) although data to support this are not available. Slightly dolomitized carbonate banks occur in the Ohio area where copper is reported in trace amounts present mainly in the breccia which directly underlies the banks.

During this study minor copper as malachite and chalcopyrite was noted in Upper Windsor E_1 limestone near Monastery (Figure 2) and minor galena in E_1 limestone outcrops at South River. Galena is also reported in Upper Windsor limestone in unpublished drill logs by Imperial Oil Ltd. from Captains Pond and Pomquet (Figure 2).

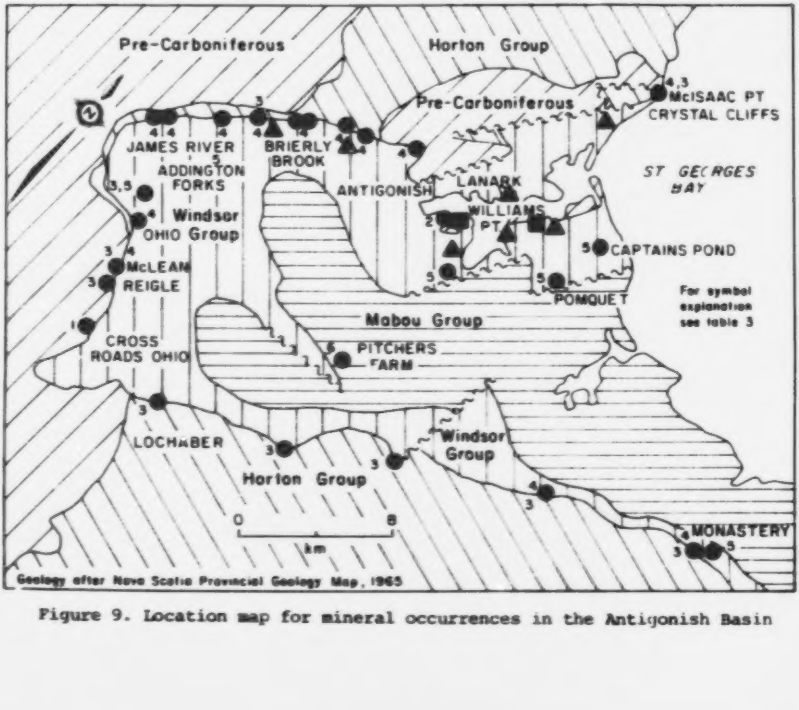
Large gypsum deposits occur near Harbour Centre, Lanark, Brierly Brook and South River where the variably hydrated lower sulphate outcrops.

The limestones and dolomites of the area were described by Murray (1975) who considered the Williams Point-Southside Harbour area to possess the most significant limestone deposits. The high grade limestone deposit at Southside Harbour is presently being quarried by Calpo Limestone Limited.

Traces of finely disseminated chalcopyrite occur in grey-green silty layers within the Hastings Formation of the Mabou Group near Pitchers Farm in the central part of the Basin (Figure 9). Chalcopyrite and malachite traces were observed associated with plant debris in the Pomquet Formation of the Mabou Group, at several points in the section exposed on the banks of the Pomquet River south of Highway 104.

LOCATION and CODE	STRAT. POSITION	ROCK TYPE	METAL OR NONMETALLIC MINERAL	MORPHOLOGY	LOCALITY
6 ●	CANSO	gy ▒	Cu	STRATABND. (DISSEM.)	PITCHERS FARM
5 ●	UPPER WINDSOR	▤	Cu, Pb	STRATABND. (DISSEM.)	MONASTERY CAPTAINS POND
4 ●	BASAL WINDSOR-UPPER HORTON	▤ ▩	Cu	STRATABND. (CONTACT ORIENTED)	BRIERLY BRK. OHIO McLEAN
3 ●	BASAL WINDSOR	▤	Cu, CALCITE BARITE, FLUORITE	VEIN	BRIERLY BRK. CAPE JACK
2 ●	BASAL WINDSOR	▦	Cu, Pb	STRATABND. (CONTACT ORIENTED)	WILLIAMS PT.
1 ●	PRECARB.	░	Cu, CALCITE BARITE	VEIN AND STRATABND.	CROSS RDS. OHIO
■	BASAL WINDSOR		LIMESTONE	STRATABND.	WILLIAMS PT.
▲	BASAL WINDSOR		GYPSUM	STRATABND.	HARBOUR CENTRE

Table 3. Classification of selected Antigonish Basin mineral occurrences (to accompany Figure 9).



Geology after Nova Scotia Provincial Geology Map, 1965

Figure 9. Location map for mineral occurrences in the Antigonish Basin

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GEOLOGY, GEOCHEMISTRY AND GEOPHYSICS OF THE SHUBENACADIE-STEWIACKE SALT DEPOSIT, HANTS AND COLCHESTER COUNTIES, NOVA SCOTIA

R. C. Boehner

INTRODUCTION

Nova Scotia has had a long history of salt exploration and exploitation. Two salt deposits are presently being mined (Figure 1): the Pugwash deposit in Cumberland County is an underground mine opened in 1959 and operated by the Canadian Rock Salt Company; the Nappan deposit, also in Cumberland County, near Amherst, is a brining mine begun in 1947 and operated by Sifto Salt (Domtar). The first underground salt mine in Canada was located at Malagash where the Malagash Salt Company began production in 1919 and was closed in 1959 because of mining difficulties.

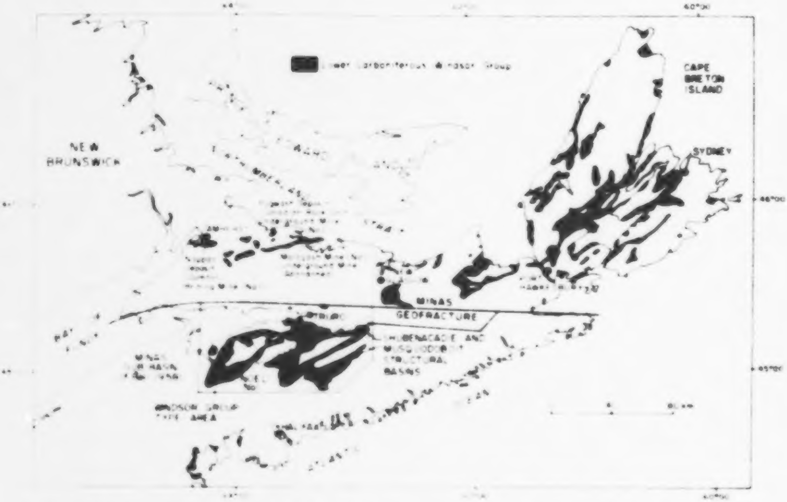


Figure 1. Location map of the Shubenacadie Basin, central Nova Scotia.

The Shubenacadie-Stewiacke salt deposit is the largest stratified deposit known in Nova Scotia. It underlies the major part of the Shubenacadie Basin (Giles and Boehner, 1979) within the Shubenacadie and Stewiacke River valleys in Hants and Colchester Counties in central mainland Nova Scotia (Figure 1).

The town of Stewiacke, near the geographic centre of the deposit area, is situated approximately 60 km north of Halifax and approximately 30 km south of Truro. These major population centres are connected by the Trans-Canada Highway 101 and by the nearby, subparallel, Canadian National Railway mainline.

Topography in the valley area is typical of the Carboniferous lowlands with gently rolling hills where elevations rarely exceed 75 m. The valley is bordered on the south by the Central Nova Scotia Uplands with elevations of up to 170 m. The north border is likewise defined by uplands with elevations of 150 m and locally exceeding 225 m.

Intensive drilling and exploration for base metal deposits has been undertaken in recent times after the discovery of the Gays River zinc and lead deposit. The abundant subsurface data produced by this exploration together with a geological mapping project by the Nova Scotia Department of Mines and Energy has resulted in a good understanding of the Windsor Group and its stratified salt deposits.

Although a significant number of base metal exploration drillholes unintentionally intersected salt in the area (Table 1), no exploration drilling specifically for salt or potash was undertaken until 1975. At this time, a series of four deep diamond-drill holes were drilled in a joint venture search for potash by Noranda Exploration Ltd. and St. Joseph Exploration Ltd. In 1976, a fifth and the deepest hole to date in the area was drilled near Stewiacke by Pacific Coast Mines.

As a result of this work and subsequent chemical analyses, a very large, relatively pure, undisturbed, stratified salt deposit is indicated. The following paragraphs will summarize the basic geology, geophysics and geochemistry of the Shubenacadie-Stewiacke deposit as it is presently known.

GEOLOGY

The stratigraphy and structure of the Lower Carboniferous (Visean) Windsor Group in the area have been described in reports and maps by Giles and Ryan (1976), Giles (1977), Boehner (1977), Ryan (1978), Giles, Boehner and Ryan (1979), Giles and Boehner (1979) and Stevenson (1959).

The Carboniferous rocks that underlie the Shubenacadie-Stewiacke Valley define the Shubenacadie Structural Basin (Figures 1 and 2) which occurs in the western part of the Minas (depositional) Sub-basin of Bell (1958). The Musquodoboit Structural Basin occurs parallel to the Shubenacadie Basin but contains no salt.

Within the Shubenacadie Basin, the total Carboniferous section is approximately 2000 m and was deposited with distinct angular unconformity upon the metasedimentary rocks of the Meguma Group (see Figures 2 and 3).

The Windsor Group in the Basin has a total thickness of approximately 760 m and comprises interstratified anhydrite, halite, laterally extensive fossiliferous marine carbonate, and siltstone-sandstone. The Windsor Group rocks concordantly overlie the Horton Group (where present), which consists of an uncertain thickness, (potentially up to 1000 m) of stratified sandstone, conglomerate and shale. Along the southern part of the Basin, such as at Gays River, Windsor Group rocks may onlap the Meguma Group.

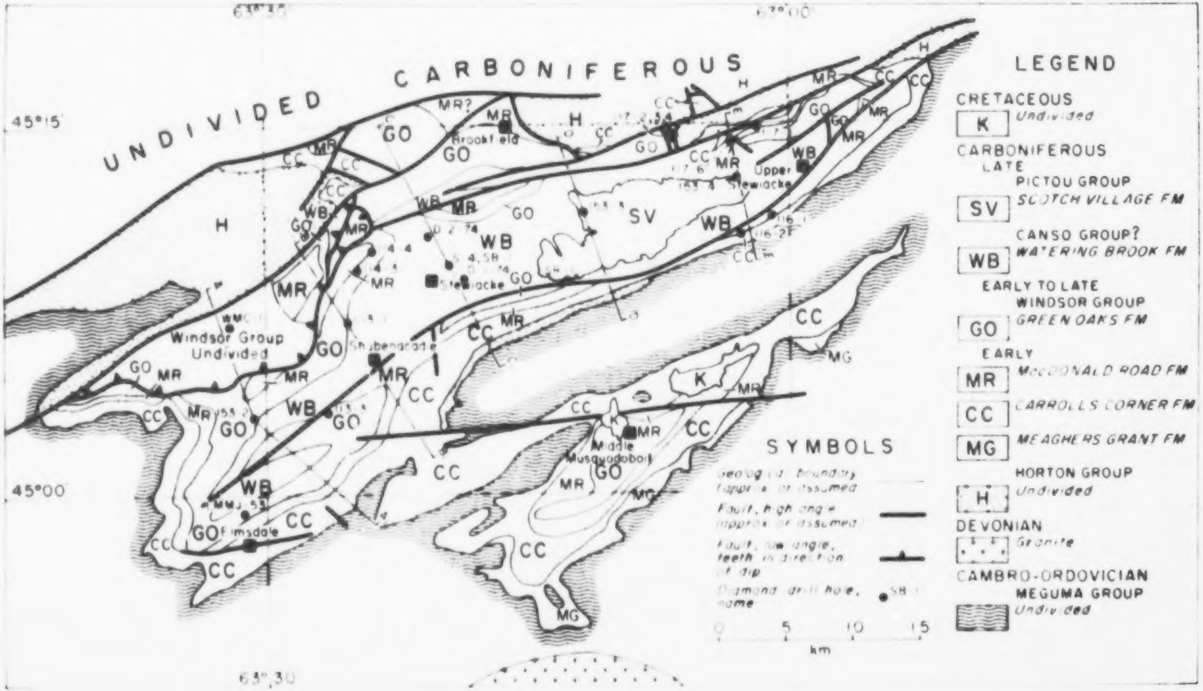


Figure 2. Geological map of the Shubenacadie Basin area.

Table 1. Drillholes intersecting salt in the Shubenacadie-Stewiacke deposit.

DRILLHOLE	NTS	MAP AREA	DEPOSIT OR OCCURRENCE	MODE OF OCCURRENCE	ELEVATION* TOP OF SALT FEET (METRES)	THICKNESS INTERSECTED FEET (METRES)	TOTAL DEPTH OF WELL FEET (METRES)	ELEVATION* OF WELL FEET (METRES)
117-1	11E3D	Shubenacadie	Shubenacadie-Stewiacke	Beds with anhydrite and siltstone	-658(200.6)	20 (6.1)	798(243.2)	120(36.6)
117-6	11E3D				-668(203.6)	25 (7.6)	778(237.1)	85(25.9)
116-1	11E3D	"	"		-523(159.4)	153(46.6)	826(251.8)	150(45.7)
116.2	11E3D	"	"	"	-637(194.2)	21(6.4)	758(231)	100(30.5)
153-4	11E3D	"	"	"	-1231(375.2)	558(170.1)	1928(587.7)	80(24.4)
117-4	11E3D	"	"	"	-569(173.4)	17(5.2)	736(224.3)	150(45.7)
117-3	11E3D	"	"	"	-565(172.2)	58(17.7)	778(237.1)	155(47.2)
117-2	11E3D	"	"	"	-562(171.3)	22(6.7)	708(215.8)	120(36.6)
153-3	11E3D	"	"	"	-1821(555)	248(75.6)	2228(679.1)	74(22.6)
					-1749(533.1)	12(3.7)		
				"	-1498(456.6)	30(9.1)		
				"	-1351(411.8)	33(10.1)		
				"	-791(241.1)	36(11)		
				"	-766(233.5)	6(1.8)		
				"	-654(199.3)	16(4.9)		
SR-1	11E3C	"	"	"	-788(240.2)	12(3.7)	1050(320)	250(76.2)
D1-74	11E3C	"	"	"	-632(192.6)	20(6.1)	727(221.6)	75(22.9)
D2-74	11E3C	"	"	"	-787(239.9)	30(9.1)	917(279.5)	100(30.5)
SB-1	11E3C	"	"	"	-1557(474.6)	893(272.2)	2928(892.5)	40(12.2)
					-1269(386.8)	30(9.1)		
					-1106(337.1)	41(12.5)		
S-4	11E3C	"	"	"	-1074(327.4)	39(11.9)	1207(367.9)	40(12.2)
114-4	11E3C	"	"	"	-680(207.3)	190(57.9)	953(290.5)	83(25.3)
114-1	11E3C	"	"	"	-750(228.6)	20(6.1)	818(249.3)	48(14.6)
153-1	11E3B	"	"	"	-935(285)	1034(315.2)	2237(681.8)	58(17.7)
					-649.5(198)	8.5(2.6)		
113-3	11E3B	"	"	"	-725(221)	20(6.1)	828(252.4)	83(25.3)
153-2	11E4A	Kennetcook	"	"	-747(227.7)	663(202.1)	1757(535.5)	170(51.8)
LMMJ-53	11D13D	Uniacke	"	"	-964(293.8)	30(9.1)	1037(316.1)	43(13.1)
WMC-1	11E4A	"	"	"				

*With respect to Mean Sea Level

Table 1. (Continued).

DRILLHOLE	LATITUDE NORTH	LONGITUDE WEST	TRACT	CLAIM	DRILL FLUID	YEAR DRILLED	OPERATOR	CORE SIZE	CORE STORED
117-1	45°14'51"	63°01'30"	98	Q	F. Water	1974	St. Joseph	BQ	Fundy Gypsum Co.
117-6	45°14'22"	63°03'32"	99	D	F. Water	1974	St. Joseph	BQ	Fundy Gypsum Co.
116-1	45°11'20"	63°00'50"	49	L	F. Water	1974	St. Joseph	BQ	Fundy Gypsum Co.
116-2	45°10'24"	63°02'45"	46	J	F. Water	1974	St. Joseph	BQ	Fundy Gypsum Co.
153-4	45°12'37"	63°02'48"	75	A	Oil Mud	1975	Noranda-St.Joseph	NQ	NSDM Debert
117-4	45°14'51"	63°06'48"	102	P	F. Water	1974	St. Joseph	BQ	Fundy Gypsum Co.
117-3	45°14'43"	63°06'48"	102	K	F. Water	1974	St. Joseph	BQ	Fundy Gypsum Co.
117-2	45°14'35"	63°06'48"	102	G	F. Water	1974	St. Joseph	BQ	Fundy Gypsum Co.
153-3	45°11'36"	63°11'56"	58	O	Oil Mud	1975	Noranda-St.Joseph	NQ	NSDM Debert
SR-1	45°8'47"	63°12'8"	15	K	F. Water	1973	Aurum	BQ	Fundy Gypsum Co.
D1-74	45°8'31"	63°18'41"	22	D	F. Water	1974	Denison	BQ	Fundy Gypsum Co.
D2-74	45°7'26"	63°20'45"	44	L	F. Water	1974	Denison	BQ	Destroyed
SB-1	45°09'18"	63°19'14"	28	B	Salt Brine	1976	US Borax	NQ/BQ	NSDM Debert
S-4	45°09'18"	63°19'15"	28	B	F. Water	1972	Denison	BQ	Fundy Gypsum Co.
114-4	45°08'56"	63°24'50"	32	Q	F. Water	1974	St. Joseph	BQ	Fundy Gypsum Co.
114-3	45°09'58"	63°23'54"	17	N	F. Water	1974	St. Joseph	BQ	Fundy Gypsum Co.
153-1	45°06'28"	63°25'14"	88	J	Oil Mud	1975	St.Joseph-Nor.	NQ	NSDM Debert
113-3	45°03'26"	63°26'30"	58	A	F. Water	1975	St.Joseph-Nor.	BQ	Fundy Gypsum Co.
153-2	45°03'14"	63°30'32"	48	P	Oil Mud	1975	St.Joseph-Nor.	NQ	NSDM Debert
LMMJ-53	44°59'09"	63°31'52"	94	B	F. Water	1974	Amax/Imp. Oil	BQ	Unknown
WMC-1									

*With Respect to Sea Level

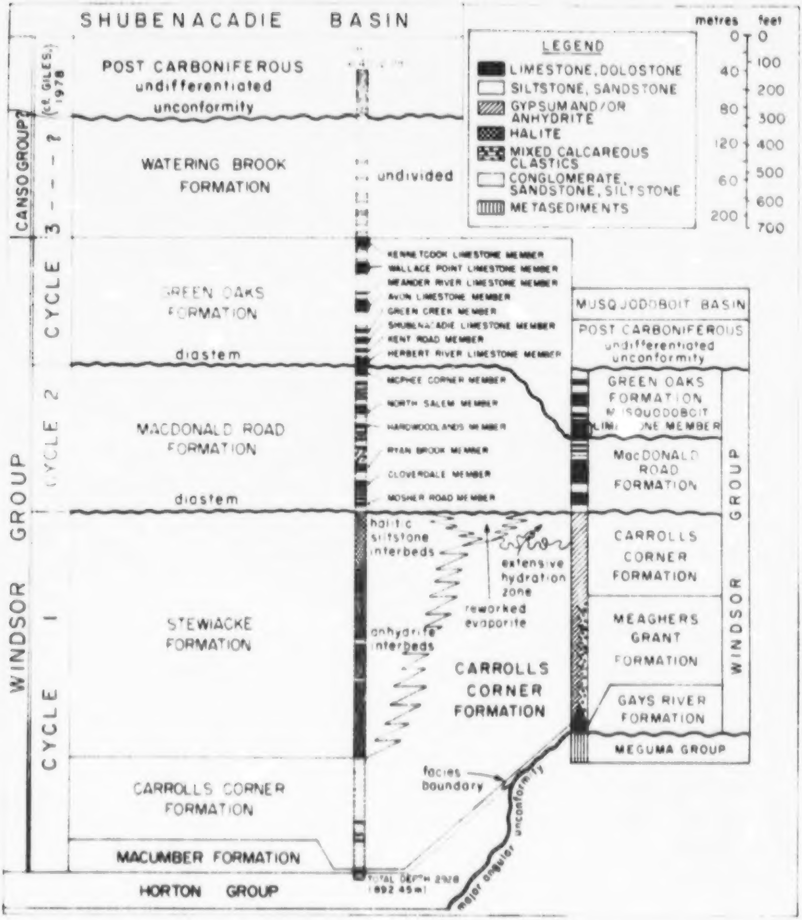


Figure 3. Stratigraphic setting of the Shubenacadie-Stewiacke salt deposit.

The Windsor Group is overlain conformably by the Watering Brook Formation comprising approximately 100 m of interbedded grey siltstone, anhydrite and minor halite. The Watering Brook Formation is in turn overlain unconformably by the Scotch Village Formation, consisting of an uncertain thickness, probably greater than 100 m, of sandstone and shale. This unit is equivalent in age to the Pictou Group.

The Shubenacadie Basin is traversed by a series of high angle normal faults with generally northeast-southwest orientations (Figure 2). These faults define a graben in the axial regions of the Basin. The longitudinal faults merge toward the northeast with the major east-west trending Minas Geofracture system. In the northern part of the Basin, the structure is complicated by numerous small fault blocks near the major longitudinal faults. Large scale overturned folds with nearly horizontal fold limbs are recognized in the western part of the Basin near the north border fault. Generally, however, the Shubenacadie Basin appears to be relatively undisturbed and the Musquodoboit Basin even less so.

Salt tectonics and deformation in the major part of the Shubenacadie Basin do not appear to be significant in comparison to other diapiric and deformed salt structures in Nova Scotia. Deformation in the salt appears only to be minor, occurring mainly as gentle warping with no evidence of intrusion or significant disturbance overall.

Faulting appears to have had little overall impact upon the Stewiacke Formation in the major part of the Basin. Exceptions to this occur in the vicinity of the major north border fault. A single salt spring occurs in this zone near drillhole 153-4. Other salt springs or indications of subsurface salt dissolution are not well known in the area. This absence is considered good evidence for the stability of the salt in the area.

STRATIGRAPHY OF HALITE ROCKS

The Windsor Group in the Shubenacadie Basin may be conveniently considered in three major subdivisions (Figures 3 and 4). The basal part of the Windsor consists of a basal carbonate with variable facies 3 m to 50 m thick depending upon the area considered, overlain by up to 400 m of stratified anhydrite and halite. This major evaporite section is the most important, but not the only salt unit in the area. The most significant halite unit, named the Stewiacke Formation, overlies and is in part a lateral equivalent of the Carrolls Corner Formation anhydrite. In the central part of the Basin, the anhydrite may be as thin as 100 m and in this instance the Stewiacke Formation halite is up to 300 m thick. Marginally, however, the anhydrite is as thick as 300 m, and the halite is absent. The Stewiacke Formation defines the Shubenacadie-Stewiacke salt deposit.

The major evaporite section in the Shubenacadie Basin is overlain disconformably by a complex sequence comprising intercalated anhydrite, marine carbonate, siltstone and minor halite rocks. This section is named the MacDonald Road Formation (Figure 3) and has a total thickness of approximately 160 m.

The MacDonald Road Formation has halite present at two stratigraphic levels. The halite units are thin (typically less than 10 m), discontinuous lenses that are probably facies equivalent with anhydrite. They are informally referred to as the upper and lower MacDonald Road salts. These units are of very limited economic significance in spite of their purity (Table 2).

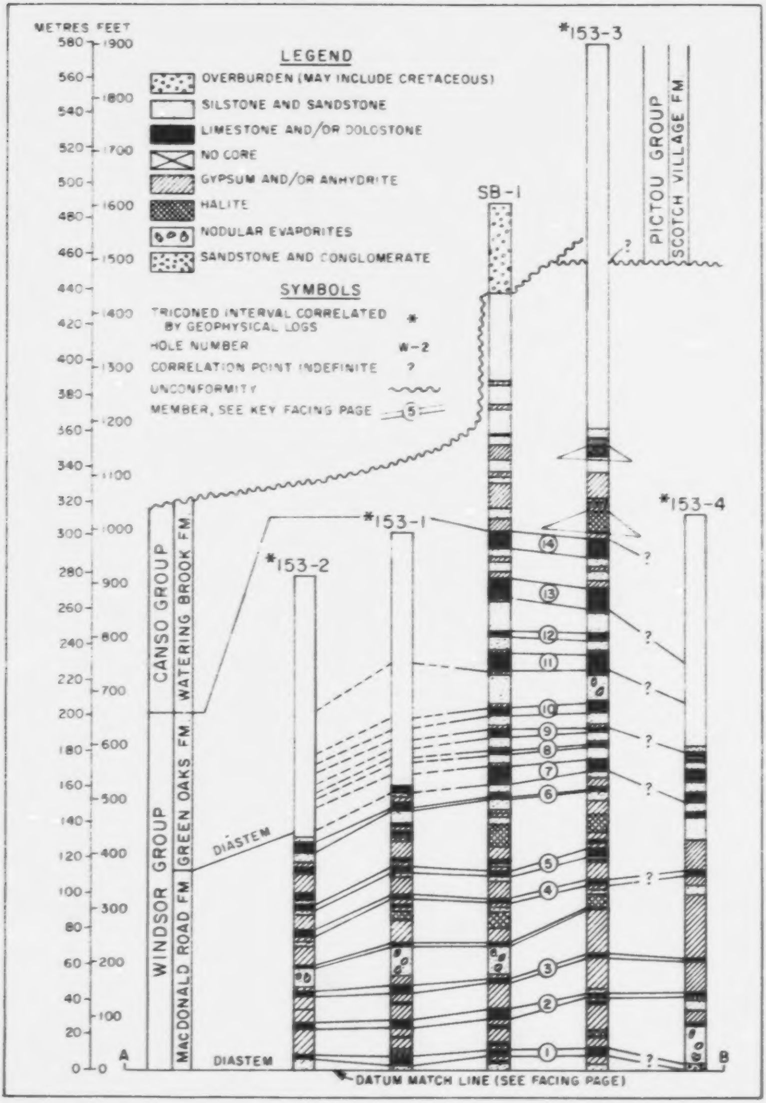
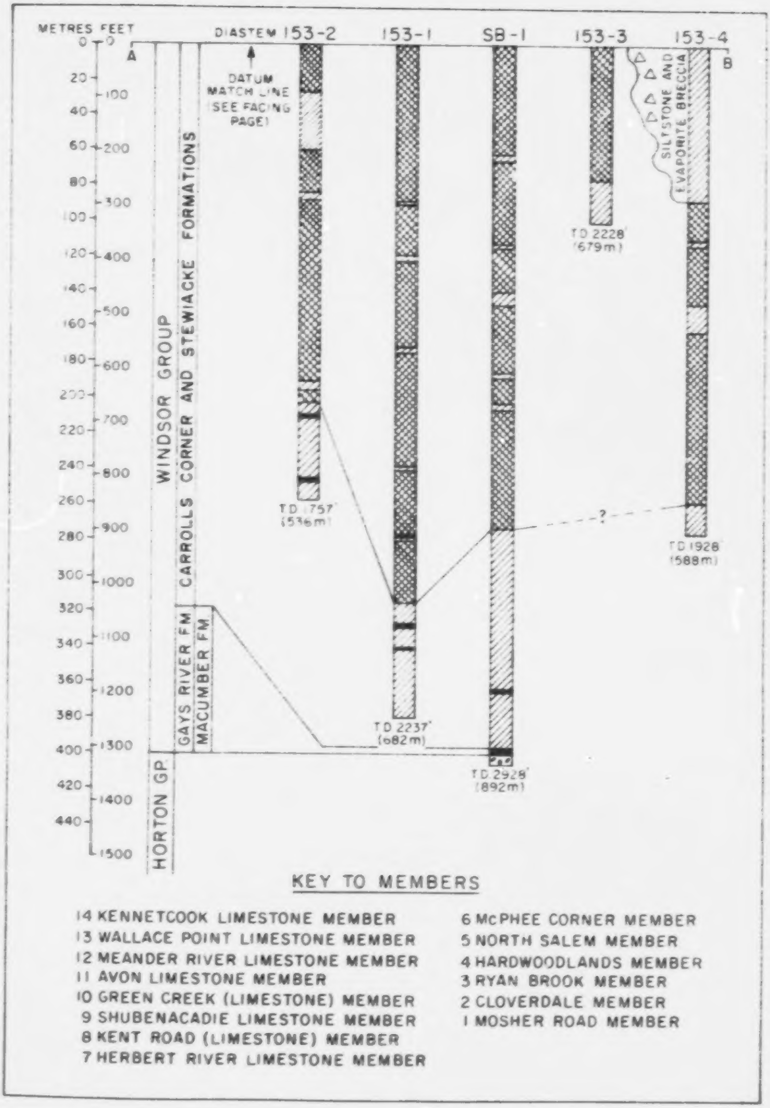


Figure 4. Deep drillhole correlation of the Shubenacadie-Stewiacke salt deposit.



KEY TO MEMBERS

14 KENNETCOOK LIMESTONE MEMBER
13 WALLACE POINT LIMESTONE MEMBER
12 MEANDER RIVER LIMESTONE MEMBER
11 AVON LIMESTONE MEMBER
10 GREEN CREEK (LIMESTONE) MEMBER
9 SHUBENACADIE LIMESTONE MEMBER
8 KENT ROAD (LIMESTONE) MEMBER
7 HERBERT RIVER LIMESTONE MEMBER
6 McPHEE CORNER MEMBER
5 NORTH SALEM MEMBER
4 HARDWOODLANDS MEMBER
3 RYAN BROOK MEMBER
2 CLOVERDALE MEMBER
1 MOSHER ROAD MEMBER

Figure 4. Continued.

Table 2. Salt analyses from drillholes SB-1 and 153-1, Shubenacadie-Stewiacke salt deposit.

SAMPLE	INTERVAL (FEET)	PERCENTAGE					MINERALS		TOTALS	
		NA2O	CL	CAO	SO4	INSOL	NACL FROM CL	CASO4 FROM SO4	WITHOUT INSOL	WITH INSOL
153- 1	705.0- 716.0	51.8	56.8	2.29	3.84	.42	93.5	5.5	99.0	99.4
153- 2	993.0-1003.0	43.5	54.0	1.46	2.65	6.56	89.0	3.8	92.7	99.2
153- 3	1003.0-1013.0	48.5	53.0	1.81	3.17	7.84	87.3	4.5	91.7	99.6
153- 4	1013.0-1023.0	41.6	49.0	1.75	2.69	13.89	80.8	3.8	84.7	98.6
153- 5	1023.0-1033.0	49.2	55.0	1.16	1.57	6.43	90.7	2.2	93.1	99.5
153- 6	1033.0-1043.0	44.5	49.6	4.77	7.73	7.61	81.7	11.0	92.8	100.4
153- 7	1043.0-1053.0	49.2	56.4	1.89	2.98	2.14	93.0	4.2	97.3	99.5
153- 8	1053.0-1063.0	48.0	54.5	1.61	2.74	5.78	89.8	3.9	93.7	99.5
153- 9	1063.0-1073.0	52.9	56.6	1.33	1.79	3.52	93.3	2.5	96.0	99.6
153-10	1073.0-1083.0	46.3	57.0	1.38	1.76	3.34	93.9	2.5	96.7	100.0
153-11	1083.0-1093.0	46.1	45.0	1.30	4.38	18.95	74.1	6.2	79.4	98.3
153-12	1093.0-1103.0	45.9	55.4	2.06	2.81	3.98	91.3	4.0	95.6	99.6
153-13	1103.0-1113.0	41.9	52.5	2.92	4.69	6.13	86.5	6.7	93.3	99.4
153-14	1113.0-1123.0	44.0	57.8	1.45	2.34	.51	95.2	3.3	98.6	99.1
153-15	1123.0-1133.0	48.0	58.0	1.29	2.11	1.74	95.5	3.0	98.5	100.3
153-16	1133.0-1143.0	51.8	58.1	1.21	1.93	1.86	95.7	2.7	98.5	100.4
153-17	1143.0-1153.0	51.0	57.9	1.31	1.95	1.74	95.3	2.8	98.2	100.0
153-18	1153.0-1163.0	50.7	57.8	1.18	1.80	2.24	95.3	2.6	97.9	100.2
153-19	1163.0-1173.0	49.8	55.9	2.50	3.99	2.07	92.1	5.7	97.9	100.0
153-20	1173.0-1183.0	45.8	51.9	3.08	5.29	6.48	85.5	7.5	93.0	99.4
153-21	1183.0-1193.0	44.7	55.1	2.12	3.68	4.53	90.8	5.2	96.0	100.6
153-22	1193.0-1203.0	48.6	57.8	1.71	2.90	.64	95.3	4.1	99.4	100.0
153-23	1203.0-1213.0	41.0	57.4	1.05	1.67	2.50	94.6	2.4	97.1	99.6
153-24	1213.0-1223.0	36.1	41.4	10.90	18.35	5.81	68.2	26.1	94.4	100.2
153-25	1223.0-1233.0	37.8	44.4	9.76	14.63	4.83	73.2	20.8	94.8	99.7
153-26	1233.0-1243.0	32.2	35.1	17.23	28.32	12.73	57.8	40.2	98.5	111.2
153-27	1243.0-1253.0	52.2	56.9	2.36	3.24	.95	93.8	4.6	98.7	99.7
153-28	1253.0-1263.0	51.1	58.4	1.16	1.84	1.71	96.2	2.6	98.9	100.6
153-29	1263.0-1273.0	42.3	46.5	6.33	11.98	7.35	76.6	17.0	93.2	100.5
153-30	1273.0-1283.0	52.7	57.4	1.31	2.15	.70	94.6	3.1	97.7	98.4
153-31	1283.0-1293.0	37.6	44.4	3.98	5.03	17.86	73.1	7.1	81.0	98.9
153-32	1293.0-1303.0	48.8	57.2	1.36	1.78	1.85	94.2	2.5	96.9	98.8
153-33	1303.0-1313.0	47.7	53.6	4.04	6.46	2.14	88.3	9.2	97.7	99.8
153-34	1313.0-1323.0	50.6	56.4	1.75	2.53	1.14	93.0	3.6	96.8	97.9
153-35	1323.0-1333.0	46.9	52.5	4.64	7.90	2.16	86.6	11.2	97.8	100.0
153-36	1333.0-1343.0	47.6	56.9	1.74	2.54	2.56	93.8	3.6	97.6	100.1
153-37	1343.0-1353.0	47.6	55.4	2.49	3.34	2.34	91.3	4.7	96.4	98.7
153-38	1353.0-1363.0	48.2	57.5	1.20	2.03	1.25	94.8	2.9	97.7	98.9
153-39	1363.0-1373.0	47.6	56.1	2.67	3.87	1.89	92.5	5.5	98.3	100.2
153-40	1373.0-1382.0	44.9	53.3	2.85	5.11	3.94	87.8	7.3	94.9	98.8
153-41	1397.0-1410.0	40.3	46.7	7.58	12.81	6.81	76.9	18.2	95.2	102.0
153-42	1410.0-1420.0	49.0	54.1	2.77	4.38	2.65	89.2	6.2	95.6	98.2
153-43	1420.0-1430.0	50.4	55.7	2.57	4.04	1.84	91.8	5.7	97.7	99.6
153-44	1430.0-1440.0	36.7	41.7	4.21	18.31	10.91	68.7	26.0	90.1	101.0
153-45	1440.0-1450.0	47.9	54.3	2.00	4.33	3.52	89.5	6.1	95.3	98.8
153-46	1450.0-1460.0	33.5	37.2	14.62	25.46	14.75	61.3	36.2	97.3	112.0
153-47	1460.0-1470.0	43.9	49.4	6.62	11.40	3.27	81.4	16.2	97.5	100.8
153-48	1470.0-1480.0	51.6	58.2	1.12	1.78	1.33	95.9	2.5	98.5	99.8
153-49	1480.0-1490.0	48.0	55.0	4.36	5.48	1.50	90.6	7.8	99.2	100.7
153-50	1490.0-1500.0	37.2	41.6	11.30	20.93	12.01	68.5	29.7	97.5	109.5
153-51	1500.0-1510.0	44.3	50.5	5.01	7.89	7.55	83.3	11.2	94.7	102.3
153-52	1510.0-1520.0	49.6	56.6	2.01	3.92	.99	93.3	5.6	98.7	99.6
153-53	1520.0-1530.0	49.6	57.7	2.22	3.45	.22	95.1	4.9	100.1	100.4
153-54	1530.0-1539.7	46.7	57.6	1.84	3.41	.34	95.0	4.8	99.7	100.1
153-55	1539.7-1554.1	31.6	34.1	11.96	19.73	22.47	56.3	28.0	84.6	107.0
153-56	1560.6-1570.6	32.6	37.7	14.44	25.16	13.31	62.0	35.7	97.6	110.9
153-57	1570.6-1580.6	44.9	53.2	4.59	7.99	1.62	87.7	11.3	99.0	100.6
153-58	1580.6-1590.6	47.1	52.2	3.96	7.32	2.74	86.0	10.4	96.2	98.9
153-59	1590.6-1600.6	34.8	40.8	12.36	20.99	10.96	67.3	29.8	97.1	108.1
153-60	1600.6-1610.6	46.3	54.7	2.89	5.28	1.75	90.1	7.5	97.4	99.2

SAMPLE	INTERVAL (FEET)	PERCENTAGE					MINERALS		TOTALS	
		NA2O	CL	CAO	SO4	INSOL	NACL FROM CL	CASO4 FROM SO4	WITHOUT INSOL	WITH INSOL
153-61	1610.6-1620.6	44.7	57.2	1.69	2.46	1.43	94.2	3.5	97.9	99.3
153-62	1620.6-1630.6	33.6	40.7	12.63	22.14	11.34	67.0	31.4	98.2	109.5
153-63	1630.6-1640.6	33.1	37.6	15.24	25.98	14.80	62.0	36.9	98.9	113.7
153-64	1640.6-1649.6	46.0	51.4	5.56	9.84	1.93	84.7	14.0	98.5	100.5
153-65	1653.8-1663.8	49.6	57.9	1.45	2.14	3.66	95.3	3.0	98.5	102.2
153-66	1663.8-1673.8	47.1	55.7	2.95	5.55	1.03	91.8	7.9	99.5	100.5
153-67	1673.8-1683.8	46.6	52.9	4.80	8.38	1.02	87.2	11.9	99.0	100.0
153-68	1683.8-1693.8	49.7	56.1	2.07	3.28	1.52	92.4	4.7	97.2	98.7
153-69	1693.8-1703.8	43.6	48.6	6.51	12.45	4.51	80.1	17.7	97.3	101.8
153-70	1703.8-1713.8	48.0	57.9	.87	1.26	1.24	95.3	1.8	97.2	98.5
153-71	1713.8-1723.8	45.8	57.2	1.92	2.86	.18	94.2	4.1	98.4	98.6
153-72	1723.8-1737.0	42.7	57.3	2.06	3.50	1.35	94.3	5.0	99.3	100.7
153-73	1742.1-1752.0	44.8	49.0	6.22	14.47	9.55	80.8	20.5	99.7	109.3
153-74	1752.0-1762.0	41.2	43.7	9.46	18.23	15.22	72.0	25.9	97.1	112.3
153-75	1762.0-1775.0	53.1	58.2	.79	1.33	1.17	95.9	1.9	97.8	99.0
153-76	1779.3-1789.3	43.0	49.6	8.71	12.85	8.21	81.8	18.2	100.9	109.1
153-77	1789.3-1795.2	50.1	56.0	2.65	4.60	2.18	92.3	6.5	98.8	101.0
153-78	1799.0-1809.0	50.4	58.1	2.29	2.24	.63	95.8	3.2	99.7	100.3
153-79	1809.0-1813.8	52.5	57.6	1.87	3.08	1.02	94.9	4.4	99.4	100.4
153-80	1816.8-1826.8	53.4	59.1	.61	1.42	.83	97.4	2.0	99.2	100.1
153-81	1826.8-1837.0	45.1	49.5	6.81	12.89	3.62	81.5	18.3	99.3	102.9
153-82	1837.0-1847.0	53.3	58.9	.88	2.40	.08	97.1	3.4	100.1	100.2
153-83	1847.0-1857.0	46.7	53.5	4.65	7.39	.66	88.2	10.5	98.9	99.6
153-84	1857.0-1867.0	51.5	58.1	1.89	5.10	.11	95.8	7.2	102.3	102.4
153-85	1867.0-1877.0	46.7	58.7	1.09	2.24	.77	96.7	3.2	99.7	100.5
153-86	1877.0-1888.1	43.7	58.4	2.54	3.21	.18	96.2	4.6	101.3	101.4
153-87	1888.1-1895.6	27.3	30.0	22.50	36.12	29.95	49.4	51.3	101.7	131.7
153-88	1908.5-1918.5	50.2	59.1	.74	1.74	.33	97.4	2.5	99.7	100.0
153-89	1918.5-1928.5	50.8	59.0	1.78	2.63	.26	97.2	3.7	101.1	101.3
153-90	1928.5-1938.5	47.3	56.5	2.91	4.51	.55	93.2	6.4	99.8	100.3
153-91	1938.5-1948.5	45.1	54.7	4.00	6.88	1.69	90.1	9.8	99.8	101.5
153-92	1948.5-1958.5	48.4	54.0	4.22	7.54	1.50	88.9	10.7	99.5	101.0
153-93	1958.5-1968.5	48.1	53.4	4.87	8.01	2.71	88.0	11.4	99.6	102.3
153-94	1968.5-1978.5	48.4	52.9	4.24	7.38	2.07	87.2	10.5	97.6	99.7
153-95	1978.5-1988.5	48.0	51.3	4.30	11.83	5.03	84.5	16.8	99.4	104.5
153-96	1988.5-1998.5	46.7	52.7	4.32	8.88	4.50	86.9	12.6	98.8	103.3
153-97	1998.5-2008.5	50.4	55.9	2.90	5.28	1.91	92.1	7.5	99.5	101.4
153-98	2008.5-2018.5	50.6	56.4	2.43	4.54	1.07	92.9	6.4	99.2	100.2
153-99	2018.5-2027.2	49.1	55.9	2.76	3.97	1.48	92.1	5.6	98.1	99.6
153SS1	1825.5- 0.0	51.7	59.3	.80	1.40	.10	97.7	2.0	99.7	99.8
153SS2	1825.6- 0.0	51.0	59.0	.59	1.06	1.01	97.3	1.5	98.7	99.8
153SS3	1030.5- 0.0	31.6	36.3	.50	.75	37.71	59.8	1.1	60.9	98.6
153SS4	2236.0- 0.0	.5	0.0	41.10	70.80	93.19	0.0	100.5	100.3	193.5
153SS5	2040.5- 0.0	52.3	60.5	.35	.19	.10	99.7	.3	100.2	100.3
HC-SS1	995.0- 0.0	49.4	60.2	.30	.44	.17	99.2	.6	99.8	100.0
SB 1AB	1146.0-1156.0	50.0	57.2	2.05	3.20	.71	94.3	4.5	99.0	99.7
SB 1CD	1156.0-1167.0	51.1	58.2	1.97	3.51	.42	95.9	5.0	100.9	101.3
SB 2AB	1167.0-1177.0	47.5	56.4	2.65	4.50	.26	93.0	6.4	99.4	99.7
SB 2CD	1177.0-1187.3	39.0	49.9	5.94	12.28	1.69	82.2	17.4	98.7	100.4
SB 3AB	1308.7-1318.7	42.9	56.3	2.86	4.66	.53	92.7	6.6	99.4	100.0
SB 3C	1318.7-1325.5	42.4	55.6	3.22	5.77	1.03	91.5	8.2	99.6	100.7
SB 4	1328.2-1339.0	42.0	52.9	3.85	7.89	2.04	87.2	11.2	97.8	99.9
SB 5AB	1597.5-1608.0	43.2	54.3	2.18	3.73	5.04	89.5	5.3	94.8	99.8
SB 5CD	1608.0-1618.0	47.8	54.3	1.55	3.53	5.10	89.5	5.0	94.2	99.3
SB 6AB	1618.0-1628.0	48.9	53.5	1.63	2.94	6.64	88.2	4.2	92.3	99.0
SB 6CD	1628.0-1638.0	54.8	56.3	1.63	2.49	2.86	92.7	3.5	96.4	99.2
SB 7	1638.0-1648.0	43.7	51.2	1.94	2.94	10.53	84.4	4.2	88.8	99.3
SB 8	1648.0-1658.0	46.6	54.0	3.16	5.54	3.35	89.0	7.9	96.8	100.1
SB 9	1658.0-1668.0	51.4	57.1	1.54	2.74	1.97	94.0	3.9	97.9	99.9
SB10	1668.0-1678.0	47.7	54.6	2.51	4.66	3.15	90.0	6.6	96.5	99.6
SB11	1678.0-1688.0	46.6	53.4	3.34	5.32	2.85	88.0	7.6	95.7	98.5
SB12	1688.0-1698.0	49.5	58.1	.92	1.81	1.17	95.7	2.6	98.2	99.3
SB13	1698.0-1708.0	51.4	55.8	2.33	3.71	2.21	92.0	5.3	97.4	99.6
SB14	1708.0-1718.0	49.4	56.4	1.76	2.76	2.40	93.0	3.9	97.0	99.4
SB15	1718.0-1728.0	46.3	51.4	4.86	9.10	2.89	84.7	12.9	97.3	100.2

SAMPLE	INTERVAL (FEET)	PERCENTAGE					MINERALS		TOTALS	
		NA2O	CL	CAO	SO4	INSOL	NACL FROM CL	CASO4 FROM SO4	WITHOUT INSOL	WITH INSOL
SB16	1728.0-1738.0	42.5	48.1	8.00	14.52	2.38	79.3	20.6	99.6	102.0
SB17	1738.0-1748.0	49.5	55.0	3.09	5.12	1.92	90.6	7.3	97.9	99.8
SB18	1748.0-1758.0	49.9	55.4	2.10	2.55	4.18	91.3	3.6	95.4	99.5
SB19	1758.0-1768.0	50.9	57.2	1.44	2.39	1.21	95.1	3.4	98.5	99.7
SB20	1768.0-1778.0	48.2	55.3	2.96	5.16	1.16	91.1	7.3	98.4	99.6
SB21	1778.0-1788.0	48.7	54.9	2.55	4.58	2.88	90.4	6.5	96.8	99.7
SB22A	1788.0-1795.2	50.5	57.2	1.29	2.14	1.42	95.1	3.0	98.2	99.6
SB23	1805.3-1815.3	49.4	46.1	6.22	13.55	6.46	76.0	19.2	94.4	100.8
SB24	1815.3-1825.3	41.2	53.9	8.64	5.22	3.69	88.8	7.5	100.2	103.9
SB25	1825.3-1835.3	40.6	44.5	9.99	17.00	7.99	73.3	24.1	97.5	105.5
SB26	1835.3-1845.3	40.6	45.2	9.26	16.82	4.95	75.4	23.9	99.2	104.1
SB27	1845.3-1855.3	44.3	49.4	6.51	12.61	3.09	81.4	17.9	98.7	101.8
SB28	1855.3-1865.3	52.6	58.5	1.20	1.94	.42	96.4	2.8	99.2	99.6
SB29	1865.3-1876.6	48.3	55.2	2.62	5.07	.99	91.8	7.2	98.8	99.8
SB30	1880.7-1890.7	40.5	46.3	7.14	14.28	6.26	76.2	20.3	95.6	101.9
SB31	1890.7-1900.7	43.5	50.0	5.75	11.04	3.04	82.4	15.7	97.5	100.6
SB32	1900.7-1910.7	46.8	54.9	3.16	4.28	1.70	90.4	6.8	97.5	99.2
SB33	1910.7-1920.7	32.9	37.2	14.77	27.18	9.80	61.3	38.6	99.1	108.9
SB34	1920.7-1930.7	42.0	48.9	7.38	14.48	1.94	80.5	20.6	100.3	102.2
SB35	1930.7-1940.7	41.5	48.2	7.67	13.81	1.08	79.4	19.6	98.8	99.8
SB36	1940.7-1950.7	47.8	56.0	2.44	4.61	.80	92.3	6.5	98.7	99.5
SB37	1950.7-1960.7	45.5	52.8	4.75	8.27	.29	86.9	11.7	98.6	98.9
SB38	1960.7-1970.7	48.7	56.5	1.81	3.39	1.07	93.2	4.8	97.9	98.9
SB39A	1970.7-1976.5	39.6	46.2	9.84	16.96	.78	76.1	24.1	100.1	100.9
SB40	1982.2-1992.2	46.6	54.1	4.30	7.40	.99	89.2	10.5	99.6	100.6
SB41	1993.5-2003.5	50.2	57.2	2.18	2.98	.35	94.2	4.2	98.7	99.1
SB42	2003.5-2013.5	51.5	58.7	.71	1.40	.77	96.7	2.0	98.6	99.4
SB43	2013.5-2023.5	46.8	57.5	1.95	3.48	.39	94.8	4.9	99.6	100.0
SB44	2023.5-2033.5	45.5	57.2	2.45	4.05	.36	94.3	5.8	100.1	100.5
SB45	2033.5-2043.5	41.0	51.6	4.96	9.43	2.42	85.0	13.4	98.0	100.4
SB46	2043.5-2053.5	47.7	59.1	.58	1.31	.84	97.4	1.9	99.2	100.0
SB47A	2053.5-2061.5	38.0	49.6	7.50	13.59	3.57	81.7	19.3	100.7	104.3
SB48	2077.5-2087.5	63.1	59.2	.42	1.53	.43	97.6	2.2	99.5	99.9
SB49	2087.5-2097.5	54.4	60.0	.40	.97	.33	98.8	1.4	100.0	100.4
SB50	2097.5-2107.5	53.4	59.6	.38	.74	.20	98.3	1.1	99.3	99.5
SB51	2107.5-2117.5	44.7	50.2	3.67	11.80	7.55	82.7	16.8	97.2	104.7
SB52	2117.5-2127.5	51.2	54.5	3.72	6.79	.29	89.8	9.6	99.3	99.6
SB53	2127.5-2137.5	52.2	57.6	6.13	3.20	.20	95.0	4.5	102.6	102.8
SB54	2137.5-2147.5	47.4	51.9	6.08	10.30	.61	85.5	14.6	100.2	100.8
SB55	2147.5-2157.5	45.6	51.1	6.17	11.15	.97	84.2	15.8	99.8	100.8
SB56	2157.5-2167.5	45.3	50.4	6.35	9.59	3.98	83.1	13.6	97.2	101.2
SB57	2167.5-2177.5	40.6	46.7	8.53	13.64	4.60	77.0	19.4	96.8	101.4
SB58	2177.5-2187.5	24.2	27.9	6.68	10.20	36.66	46.0	14.5	61.0	97.7
SB59	2187.5-2194.7	36.7	41.1	2.66	4.21	24.23	67.8	6.0	73.9	98.1
SB60	2194.7-2204.0	40.9	48.3	3.31	6.10	11.13	79.6	8.7	88.1	99.2
SB61	2214.0-2223.0	32.0	38.9	5.51	7.93	23.28	64.1	11.3	76.0	99.3
SB62	2223.0-2235.3	42.1	46.7	7.68	13.50	4.12	76.9	19.2	96.0	100.1
SB63	2235.3-2245.5	49.9	57.1	2.08	3.45	.39	94.0	4.9	99.0	99.4
SB64	2245.5-2255.5	42.3	52.0	5.45	8.65	1.98	85.8	12.3	98.3	100.3
SB65	2255.5-2262.4	43.9	52.0	5.44	9.33	1.19	85.7	13.2	98.9	100.1
SB66	2271.8-2281.8	48.7	57.6	2.22	2.77	.79	94.9	3.9	99.3	100.1
SB67	2281.8-2291.8	49.9	57.7	2.14	3.14	1.29	95.1	4.5	99.7	101.0
SB68	2291.8-2301.8	51.5	57.3	1.82	3.14	.26	94.3	4.5	98.8	99.0
SB69	2301.8-2311.8	52.8	57.5	1.77	2.81	.22	94.8	4.0	98.8	99.1
SB70	2311.8-2321.8	50.7	58.0	2.24	3.09	.22	95.6	4.4	100.3	100.5
SB71	2321.8-2331.8	50.2	57.6	1.35	3.21	.23	94.9	4.6	99.3	99.5
SB72	2331.8-2341.8	48.6	57.6	2.04	2.37	.41	94.9	3.4	98.7	99.1
SB73	2341.8-2351.8	48.5	56.9	2.19	4.36	.30	93.7	6.2	99.6	99.9
SB74	2351.8-2361.8	51.0	56.8	2.26	3.68	.88	93.6	5.2	98.9	99.8
SB75	2361.8-2371.8	49.8	58.4	1.50	2.22	.35	96.3	3.2	99.6	99.9
SB76	2371.8-2381.8	47.0	56.7	2.38	3.50	.72	93.5	5.0	98.7	99.4
SB77	2381.8-2391.8	49.0	55.4	4.13	4.67	1.22	91.3	6.6	98.9	100.2
SB78	2391.8-2401.8	49.0	56.6	.38	4.04	.90	93.2	5.7	97.6	98.5
SB79	2401.8-2411.8	45.3	54.3	.39	7.45	2.25	89.5	10.6	97.2	99.5

SAMPLE	INTERVAL (FEET)	PERCENTAGE					MINERALS		TOTALS	
		NA2O	CL	CAO	SO4	INSOL	NACL FROM CL	CASO4 FROM SO4	WITHOUT INSOL	WITH INSOL
SB80	2411.8-2421.8	47.7	53.5	4.75	7.64	2.11	88.2	10.8	99.3	101.4
SB81	2421.8-2422.8	47.2	55.3	3.94	6.14	1.76	91.1	8.7	100.1	101.9
SB82	2431.8-2441.8	47.2	54.9	4.75	5.82	2.44	90.4	8.3	99.7	102.1
SB83	2441.8-2451.8	47.5	53.8	4.38	6.36	3.55	88.6	9.0	98.1	101.7
SB84	2451.8-2461.8	50.0	56.1	3.19	4.06	1.62	92.4	5.8	98.7	100.3
SB85	2461.8-2471.8	52.5	57.0	2.42	3.36	1.09	93.9	4.8	99.0	100.1
SB86	2471.8-2481.8	47.4	55.7	3.33	4.44	1.78	91.7	6.3	98.6	100.3
SB87	2481.8-2490.2	43.8	51.1	6.67	10.33	4.27	84.2	14.7	99.3	103.6
SBSS1	2083.0- 0.0	51.6	59.3	.56	1.00	.14	97.7	1.4	99.1	99.2
SBSS2	2083.1 0.0	51.4	58.9	.56	1.18	.77	97.1	1.7	98.6	99.4
SBSS3	1855.5- 0.0	51.4	59.1	.32	.61	1.43	97.4	.9	98.3	99.7
SBSS4	2495.0- 0.0	.9	1.6	39.79	70.32	69.65	2.6	99.9	101.5	171.1

The MacDonald Road Formation in the Shubenacadie Basin is overlain disconformably by the Green Oaks Formation, which has a thickness of approximately 140 m (Figures 3 and 4). This section comprises interstratified laterally extensive marine carbonate, siltstone with minor but locally abundant anhydrite. No halite is known from this section, although thin units could be expected in highly evaporitic sections. If present these halite beds would probably be of little economic significance.

In the Shubenacadie Basin the uppermost carbonate member of the Green Oaks Formation is conformably overlain by a sequence of interbedded siltstone, anhydrite and locally minor halite, named the Watering Brook Formation. Representation in drill core is limited but is known to be up to 100 m thick. Similar to the MacDonald Road Formation, the halite is laterally discontinuous and occurs in thin intervals at several stratigraphic levels. Thickness rarely exceeds 10 m and these salt units, as in previously outlined thin halite beds, are also considered to be of very limited economic importance.

Stewiacke Formation

The Stewiacke Formation is the most important stratigraphic unit with respect to potential salt exploration or development. It is the thickest and most laterally extensive salt unit in the area and is the largest relatively undisturbed stratified salt deposit known in Nova Scotia. The Stewiacke Formation is known from five deep drillhole intersections: 153-2, 153-1, SB-1, 153-3 and 153-4, located along the axis of the Basin (Figures 2 and 4). It is from these holes, together with the basic geology determined from mapping and numerous other drillholes without salt or with partial salt sections and gravity data that the salt deposit is defined.

Lithology

The Stewiacke Formation comprises up to 300 m of banded medium- to coarse-grained halite (0.5 to 1.5 cm), with many thin interbeds of anhydrite near the base and green halitic siltstone near the top. No potash minerals are reported or indicated in the Formation.

The banding in the salt occurs as regular but ill-defined layers 5 to 8 cm thick of alternating clear pure medium grained halite and smoky grey halite with finely dispersed anhydrite, organic and clay materials.

The anhydrite layers in the Stewiacke Formation range in thickness from 1 cm to 5 m but may locally reach up to 20 m or more. They are grey and bluish to brownish grey, variably halitic and locally have borate mineral (danburite) porphyroblasts.

Dips are typically gentle and the thin layers are observed in drill core to be gently warped and locally dislocated into s-shaped minor folded fragments. No distinct structural fabric of the type described by Boehner and Mance (1978) and Mance (1978) has been observed in the halite.

The anhydrite layers are generally most common in the lower 1/2 to 2/3 of the section. The thicker beds have no distinctive characteristics and cannot be traced with confidence between drillhole sections which are, from west to east, approximately 9.5 km, 9.5 km, 11 km, and 12.5 km apart (Figures 2 and 4).

Near the top of the salt the insoluable interbeds consist predominantly of the grey-green laminated to massive siltstone with varying proportions of orangeish coloured halite porphyroblasts. The abundance of these layers increases upward in the section being most abundant in the upper 1/2 to 1/3 of the section. In some areas, substantially thick anhydrite beds, up to 20 m, occur in the upper parts of the Stewiacke Formation.

Chemical analyses and detailed core logging indicate the lower 30 to 60 m of the Stewiacke Formation is the purest nearly homogeneous salt section without significant anhydrite interbeds.

The Stewiacke Formation is probably in part a basinal facies equivalent to the upper part of the Carrolls Corner Formation. This facies relationship has not been defined in drilling, but is inferred to occur as a narrow intertongued zone that has not been drilled to date.

Salt Deposit Limits

In addition to the five deep penetrating holes, the Stewiacke Formation has been partially intersected in nine other holes (Table 1). Although these yield limited internal stratigraphic data, they do aid in defining the minimum lateral extent of the salt. Using all the drillhole data and the geological mapping, the salt deposit is inferred to underlie the major part of the Shubenacadie Basin. It has been drilled along a strike length of 42 km and may be extrapolated to a 50 km length. The width of the deposit is less well known, but is known to underlie a width of approximately 6 km across the axis of the Basin. This excludes the complex area near the north border fault zone. The maximum area underlain by the relatively undeformed Stewiacke Formation is inferred to be approximately 300 km^2. Thickness variations within the Stewiacke Formation are less well defined, due mainly to the lack of subsurface data in critical areas across the strike of the Basin. In the axis of the Basin, the thickness reaches 300 m, but along the margin to the southeast no thickness is present. An average thickness of 75 m is calculated for the entire area. The volume of Stewiacke Formation within this block approximates 22.5 km^3 and this would contain approximately 50 Gt (billion tonnes) of rock (15wt% insoluables).

The depth of the top of the Stewiacke Formation, in the axis of the Basin, reaches a maximum of approximately 555 m in 153-3 but generally lies between 300 to 350 m where the Watering Brook Formation is thin (Figures 2 and 5). Around the perimeter of the Basin, the top of the salt should occur at depths of 100 to 200 m depending upon the remaining thickness of the MacDonald Road and Green Oaks Formations. A structure contour map of the top of the Stewiacke Formation or Carrolls Corner Formation (Figure 5) depicts the elevation of the top of the salt where present.

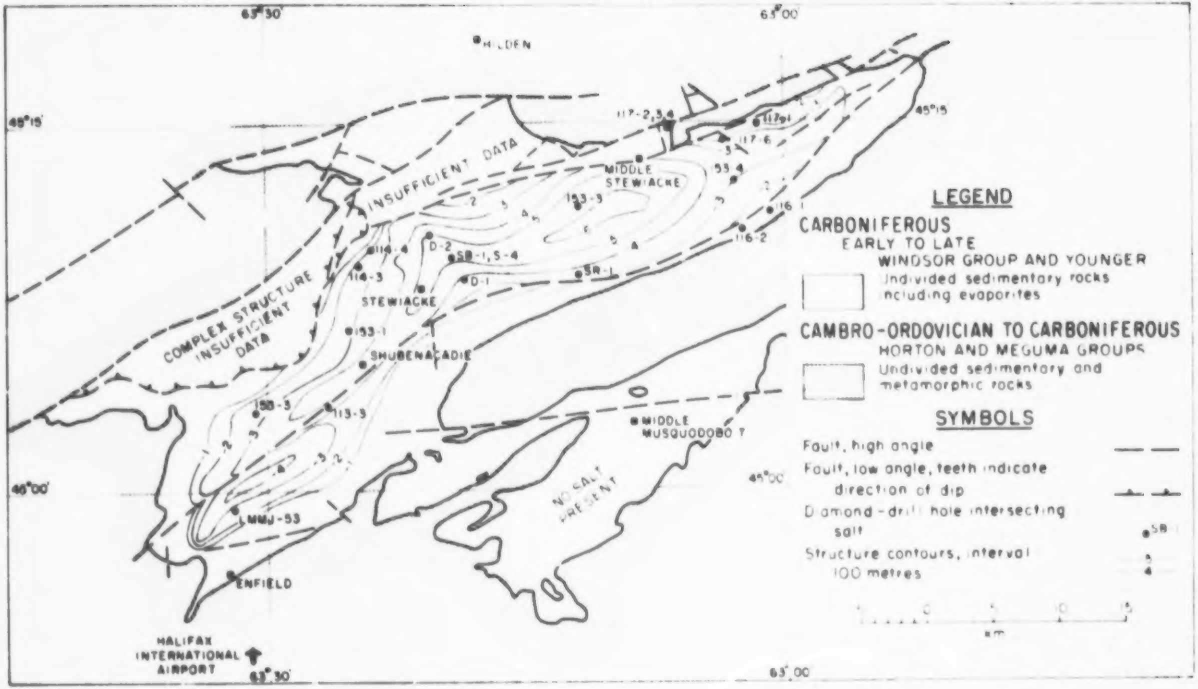

63°30'
63°00'
45°15'
45°00'
HILDEN
INSUFFICIENT DATA
COMPLEX STRUCTURE INSUFFICIENT DATA
117-2,3,4
117-6
153-4
116-1
116-2
MIDDLE STEWIACKE
153-3
SR-1
D-2
SB-1, S-4
D-1
114-4
114-3
STEWIACKE
153-1
SHUBENACADIE
150-3
113-3
LMMJ-53
ENFIELD
HALIFAX INTERNATIONAL AIRPORT
MIDDLE MUSQUODOBOIT
NO SALT PRESENT
LEGEND
CARBONIFEROUS
EARLY TO LATE
WINDSOR GROUP AND YOUNGER
Undivided sedimentary rocks including evaporites
CAMBRO-ORDOVICIAN TO CARBONIFEROUS
HORTON AND MEGUMA GROUPS
Undivided sedimentary and metamorphic rocks
SYMBOLS
Fault, high angle
Fault, low angle, teeth indicate direction of dip
Diamond-drill hole intersecting salt
Structure contours, interval 100 metres
0
5
10
15
km

Figure 5. Structural contour map, datum at top of Stewiacke Formation.

GEOPHYSICAL

The major part of the Shubenacadie Basin is included on a Bouguer gravity anomaly map at a scale of two inches equals one mile. This map (simplified in Figure 6) is based upon the Nova Scotia Research Foundation 11E3 and 11E4 Gravity Map Sheets, with newer infill stations by St. Joseph Exploration. The gravity anomaly patterns within the Basin may be used to qualitatively interpret the Stewiacke Formation thickness distribution and the effect of the thickness of overlying strata established in the drilling. Cross sections depicting geology and gravity profiles of several lines transverse to the structural strike (Figures 2 and 6) are presented in Figure 7. The relationships and variation in the gravity appear to be determined mainly by known variations in the geology i.e. depth to salt, thickness of salt and the nature of overlying and underlying strata. A differential of up to 20 mGal exists between the minima in the Basin centre and the maxima along the southern border of the Basin. The generally stratified nature and minimal structural disturbance together with good deep drillhole control make the Shubenacadie-Stewiacke deposit an excellent site for detailed quantitative gravity modelling.

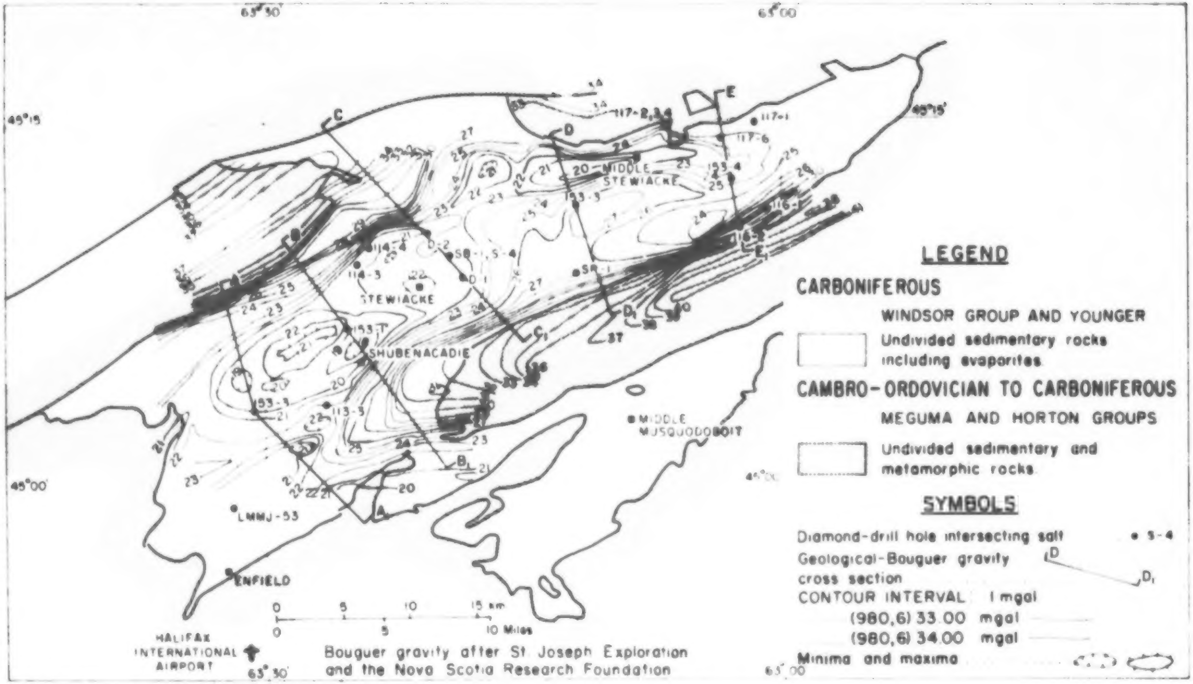
Downhole geophysical logs including gamma ray, neutron, density and caliper logs are available for four of the deep holes 153-1, 153-2, 153-3 and 153-4. These logs are useful in verifying lithologic correlation and in the case of 153-1, which has detailed chemical analyses, an assessment of grade may be made. In the event of future exploration drilling, coring could be restricted to the Stewiacke Formation and eventually, it might not be necessary to core if the drilling proves the deposit to be as consistent as believed. In this case, geophysical logs could be used exclusively in partially cored or uncored (triconed) drillholes.

GEOCHEMISTRY

Two deep drillholes that penetrated the Stewiacke Formation were selected for detailed chemical analyses in order to assess the purity of the salt deposit. These salt sections, approximately 9.5 km apart, were representative of the Stewiacke Formation and of the upper and lower MacDonald Road Formation salts.

The salt sections in the drillholes were logged in detail and the core split. Intervals of approximately 10' (3 m) were bagged as bulk samples of continuous halved core. Continuous anhydrite sections more than 1 m thick were avoided in sampling, with intervals stopping at these units. Fortunately, these were not common and sampling is nearly continuous. Whole rock analyses were carried out at the Nova Scotia Technical College, Laboratory for Investigation of Minerals. The following major oxides and trace elements were analyzed: Na_2O, CaO, MgO, K_2O, Fe_2O_3, SO_4, CO_3, Cl, Br, Rb, B and per cent insoluable was measured. In addition, U_2O_3 analyses were done by Atomic Energy of Canada Limited in Ottawa. Major oxide analyses and insoluable residue results together with calculated mineral components are presented in Tables 2 and 3. Manipulation and profiling of these data are in progress.

Preliminary assessment of the data using Br and Sr ratios together with K_2O analyses indicate a probable low degree of brine concentration and little promise for potash salt precipitates.



Bouguer gravity after St Joseph Exploration and the Nova Scotia Research Foundation

Figure 6. Bouguer gravity anomaly map, Shubenacadie Basin.

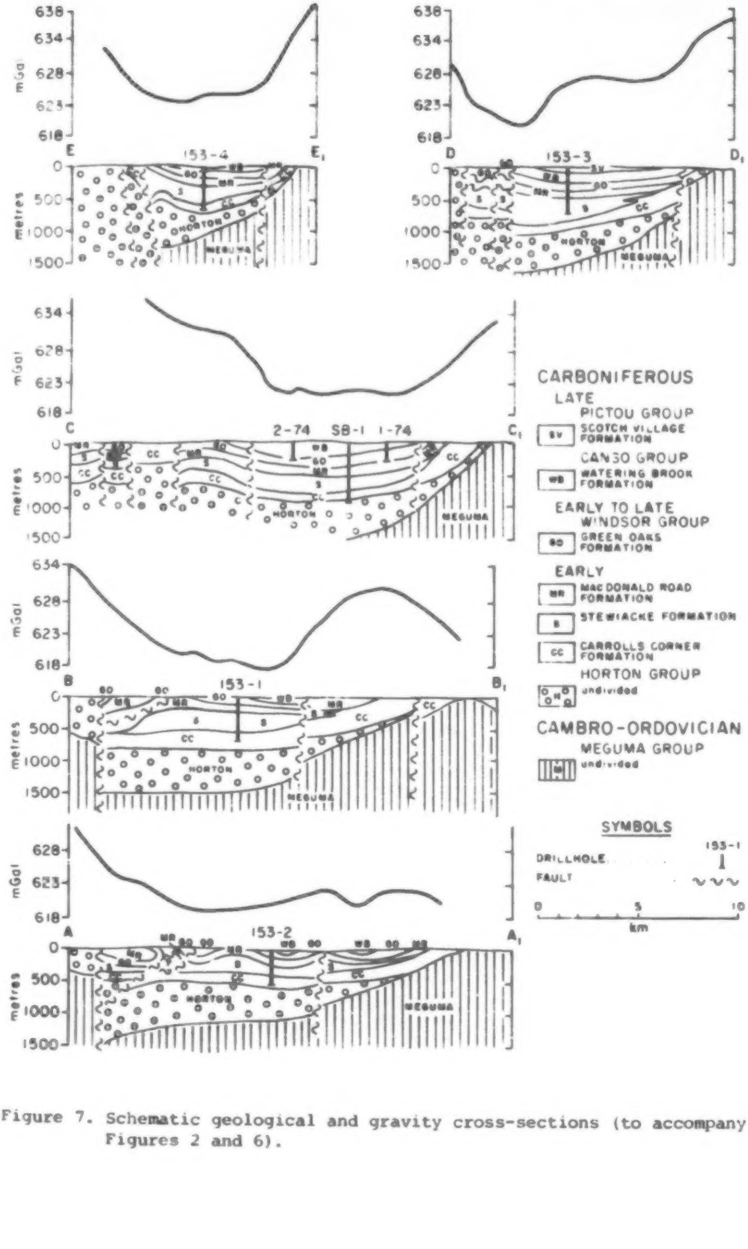


Figure 7. Schematic geological and gravity cross-sections (to accompany Figures 2 and 6).

The Stewiacke Formation section, sampled in 153-1, has an average analysis of 86.79% NaCl and a total thickness of 315 m while the same section in SB-1 has an average analysis of 87.85% NaCl and a total thickness of 272 m. The analyses indicate very few high purity salt sections, but this is only an apparent feature if consideration is given to the sampling method and the mode of occurrence of easily separable, discrete, solid anhydrite impurity layers within the continuously sampled intervals. In fact, a substantial proportion of salt is probably of mineable quality with minor benefication.

Table 3. Summary of salt grades and intervals from drillholes 153-1 and SB-1, Shubenacadie-Stewiacke deposit.

Sample Numbers	Per cent NaCl	Thickness feet	metres	Interval feet	metres
Drillhole 153-1					
153-14-19	94.87	60.0	(18.2)	1113.0-1173.0	(339.3-357.5)
153-21-23	93.58	30.0	(9.1)	1183.0-1213.0	(360.6-369.7)
153-27-39	89.79	130.0	(39.6)	1243.0-1373.0	(378.9-418.5)
153-65-72	89.20	83.2	(25.4)	1653.8-1737.0	(504.1-529.5)
153-75-86	90.48	126.1	(38.4)	1762.0-1888.1	(537.1-575.5)
153-75-89	91.46	166.5	(50.7)	1762.0-1928.5	(537.1-587.8)
Drillhole SB-1					
SB-09-14	92.13	60.0	(18.3)	1658.0-1718.0	(505.3-523.6)
SB-17-22	92.16	57.7	(17.6)	1738.1-1795.7	(529.8-547.4)
SB-41-46	93.72	60.0	(18.2)	1993.5-2053.5	(607.6-625.8)
SB-48-53	93.70	60.0	(18.2)	2077.5-2137.5	(633.2-641.4)
SB-66-78	94.31	130.0	(39.6)	2271.8-2401.8	(692.4-732.0)
SB-66-86	92.95	210.0	(64.0)	2271.8-2481.8	(692.4-756.4)

CONCLUSIONS

The Shubenacadie-Stewiacke salt deposit is very large, relatively undisturbed stratified halite deposit with a geological resource in the order of 50 Gt (billion tonnes) (85% NaCl). The depth of the salt in the major part of the area may be a major restriction to possible underground mining exploitation, as the top of the salt occurs generally below 350 m. Only in the area west of Shubenacadie does the top of the salt appear above a depth of 250 m. In the deepest part of the Basin the depth to the base of the salt may exceed 750 m.

Chemical analyses in two Stewiacke Formation sections, 9.5 km apart, indicate average whole rock analyses of 86.79% and 87.85% NaCl over intervals of 315 m and 272 m respectively. NaCl grades, in intervals of 10 m or more, are in the order of 92-94% whole rock and may be up to 93% in intervals of up to 65 m.

The stratified nature, purity, virtual absence of salt springs, great lateral extent, thickness and depth would make the deposit highly suitable for underground storage or brining mine development. Future development of the deposit will probably be primarily controlled by economics rather than by geology.

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A RUGOSE CORAL FROM THE E_1 LIMESTONE IN THE POMQUET RIVER SECTION, ANTIGONISH COUNTY, AND THE IMPLICATIONS FOR WINDSOR GROUP STRATIGRAPHY

P. S. Giles

INTRODUCTION

Sage (1954) drew attention to the section of the Windsor Group exposed in the so-called Pomquet River section (Figure 1), and believed that the exposures were possibly the most complete and representative to be found in Nova Scotia. Thus, the author was drawn to this section in order to expand the understanding of rock units in the upper parts of the Group. In conjunction with R. C. Boehner, new maps of the section were prepared, presenting significant revision to the work of Sage (1954). No attempt is made here to describe the section fully. Instead, a single carbonate member and closely associated strata are extracted for special consideration. This carbonate, termed the A_2 limestone (informal) by Sage (1954), as indicated on his detailed map of the river section, is reassigned here through lithologic comparison with other of Sage's (1954) and Stacey's (1953) sections, to equivalence with the E_1 limestone.

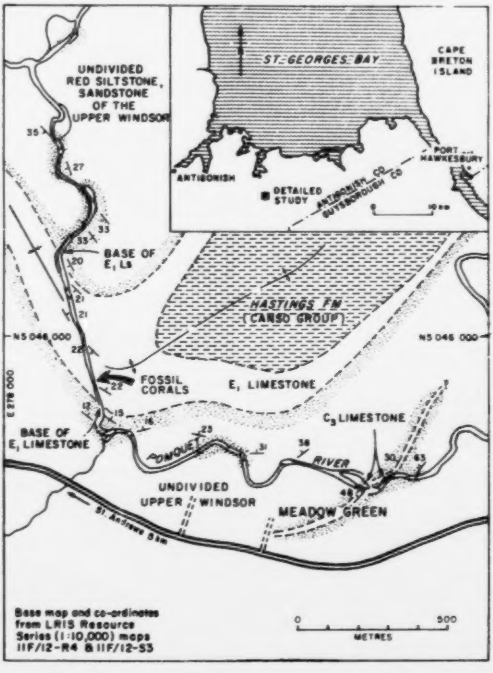

Figure 1. Geological map and location of the E_1 limestone in the Pomquet River section, Antigonish County.

DESCRIPTION OF THE LIMESTONE MEMBER

The outcrop, designated the A_2 limestone by Sage, dips gently northwards and strikes obliquely to the Pomquet River at that point. The lower contact with grey shales and mudstones is fully exposed and appears to be both concordant and conformable. The section was measured and described from the base to the top, beginning in fine- to medium-grained sandstone and siltstone which lies beneath the limestone member. These red beds are exposed for many tens of metres upstream from the carbonate in continuous section. A change to grey colour occurs very abruptly approximately 2 m beneath the carbonate.

The lowermost beds of the carbonate comprise finely crystalline limestone, vaguely banded and containing no apparent allochemical constituents or fossils. These beds form a basal unit which passes upwards across a bedding surface, into oolitic and sparsely crinoidal bioclastic limestone. The oolitic carbonate occurs in discontinuous lenses within the finely bioclastic limestone. The biogenic debris is concentrated in thin zones within thicker beds and attests to current sorting of the debris. Some pelmatazoan columnal fragments reach 1.5 cm in length. The upper contact of this interval is not sharply defined. The main indicator of lithologic change is a change to thicker, more uniform bedding in the overlying interval, and an increasing dolomite content in the overlying unit.

The remainder of the limestone member can be subdivided only with difficulty because of an overall uniformity in lithology and bedding character except for a few thin and widely separated beds which appear to be either exceptionally bioturbate or more highly bioclastic than associated strata. These beds are combined to form a major lithologic unit which extends to the top of the main body of the limestone member (Figure 2). In the upper parts, all beds are heavily bioturbate with both vertically and horizontally oriented burrows. Burrow size reaches 1 cm in diameter and varies from 1 to 5 cm in length. No particular preferred orientation was noted for the burrows.

Bituminous material is abundant in these upper beds where it is concentrated along numerous styolite surfaces. The bituminous material is amorphous and hard although the rock has a distinctly fetid odour when freshly broken.

Near the top of the exposed section, at the locality measured, a peculiar siltstone-matrix breccia occurs. The rocks at this point in the section are very nearly flat-lying and superpositional relationships are not totally clear. Determination of the relationship is further complicated by the fact that much of the outcrop occurs in the bed of the river. However, the relationships suggested place this limestone-siltstone breccia within the stratigraphic section separating carbonate rocks of very similar character. Also, the breccia contains blocks of similar limestone up to 30 cm in longest dimension. Approximately 2 m of limestone appear to overlie this breccia in the core of a gentle syncline. These carbonate rocks are similar in every respect to those below the breccia.

Similar relationships were noted in core from the Pomquet No. 2 diamond-drill hole (Giles, 1977), further supporting a syndepositional origin for the siltstone breccia.

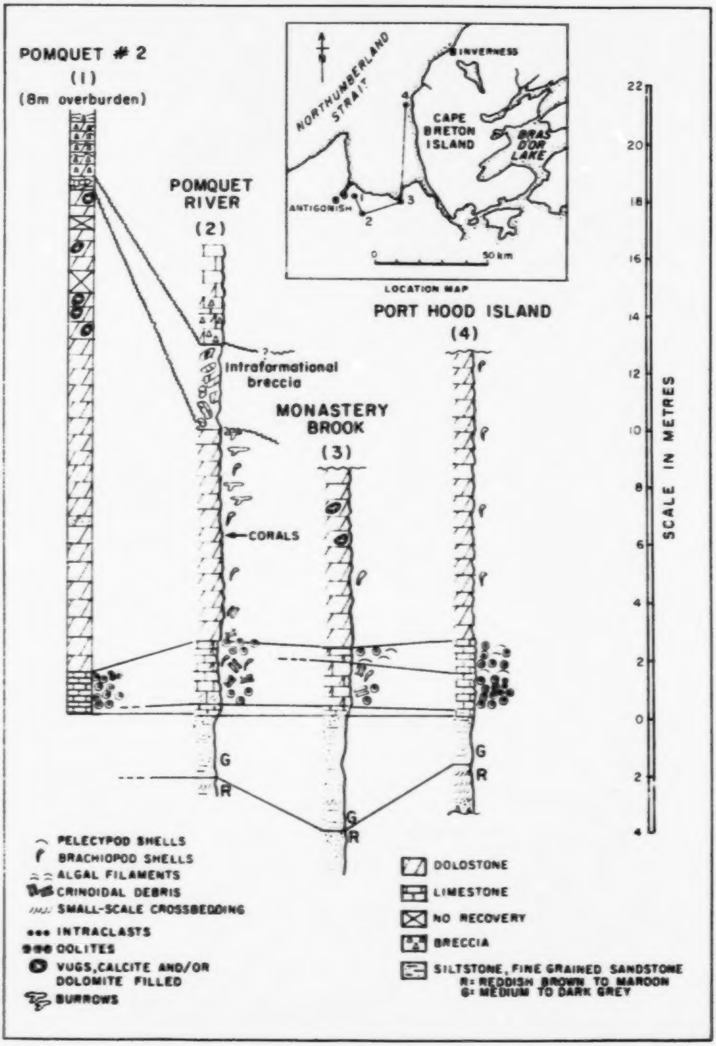

Figure 2. Lithostratigraphic correlation of the A_2 limestone of Sage (1954) (Pomquet River section) with the E_1 in contiguous sections in northeastern Nova Scotia; reassignment of the A_2, in this section, to the E_1 is recommended. The location of rugose corals in the measured section on Pomquet River is shown with an arrow.

LITHOLOGIC CORRELATION WITH THE E_1 LIMESTONE MEMBER

Sage (1954) reported the A_2 limestone to be barren of fossils, describing it merely as an earthy, yellow, cavernous limestone lying above the laminated A_1 (Macumber Formation) in the stratigraphic succession, but beneath fossiliferous limestones of Bell's (1929) B macrofaunal subzone. Sage's (1954) description of the A_2 appeared to be inapplicable to the exposure examined. Indeed, there was a strong similarity of the rock types present with those of the E_1 limestone of the Port Hood Island section, in spite of Sage's assignment to the A_2. This similarity becomes apparent in graphic plots of sections of the E_1 which were measured and described at about the same time (Figure 2) (see also Giles, 1977). These correlative sections were assigned to the E_1 by Sage (1954) and Stacey (1953), a conclusion shared by the writer. Features diagnostic of the E_1 include the following:

1) a well developed oolitic unit at or near the base, with locally developed digitate algal stromatolites (small),

2) *Schizodus* sp. in the oolitic unit,

3) thickly and evenly bedded upper portions dominating the member; sparcely fossiliferous,

4) the presence of a well developed grey shale and mudstone unit beneath the carbonate; the thickness of this unit is several orders of magnitude greater than similar rock units beneath other carbonate members,

5) the relatively great thickness of the carbonate member compared with stratigraphically lower carbonate members,

6) the common presence, in complete sections, of a thick deposit of gypsum or anhydrite above the E_1, sometimes separated from the carbonate by a small thickness of grey-green siltstone,

7) stratigraphic position at the top of the carbonate-bearing Windsor Group.

Many of these diagnostic criteria appear to be met by the postulated correlation. None refute the correlation, although evidence may be lacking. Corroborating evidence comes from the carbonate exposed upstream (downsection) from the exposure studied in detail. The former, on lithologic grounds, correlates with the distinctive C_3 limestone of the Port Hood Island section. Several concealed intervals separate this limestone from the E_1 and presumably the D_1, D_2 and D_3 limestones occupy one of these intervals. Attitudes suggest that the exposed section is monoclinal and concordant throughout and probably represents a conformable succession from the C_3 to the E_1 limestone. Thus, all available evidence supports correlation of Sage's (1954) A_2 in the Pomquet River section with the E_1 of the Port Hood Island section.

OCCURRENCE OF RUGOSE CORALS

Two specimens of rugose corals were observed within the upper part of the measured section (Figure 2). Neither was well preserved. One appeared to be in approximate longitudinal (axial) section parallel to the bed surface. The second was an oblique cross-section of a fragmental coral as exposed. Careful searching failed to reveal additional corals. The limestone bed in which the corals occurred was extremely dense and hard so that considerable difficulty was encountered in collecting the specimens in undamaged, potentially identifiable condition. Indeed, one specimen remains in the outcrop despite strenuous efforts to remove it in an undamaged condition. The specimen collected (Figure 3) cannot be rigorously identified to species since it cannot provide an axial section for study, and because of severe recrystallization related to dolomitization. The absence of dissepiments is notable, however, and appears to be characteristic of *Enniskillenia enniskilleni* (Moore and Ryan, 1976).

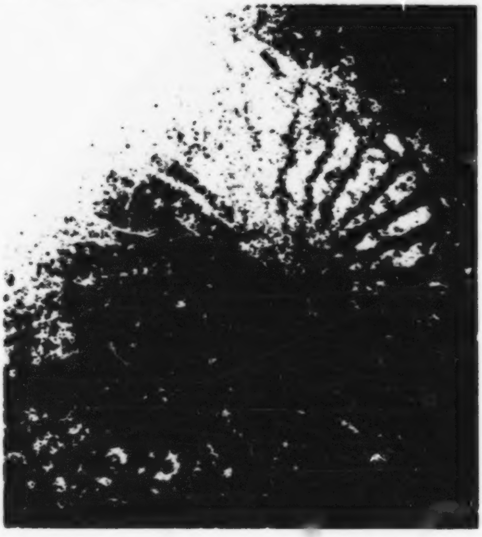

Figure 3. Cross-section (slightly oblique) of the rugose coral collected from the E_1 limestone in the Pomquet River section. Width of the photograph approximates 1 cm.

IMPORTANCE OF THE CORALS FOR REGIONAL CORRELATION

Sage (1954) correlated the E_1 with the Kennetcook Limestone Member of the type Windsor. Supporting lithostratigraphic evidence for this correlation is virtually absent, except for the common position of each member at the top of the carbonate-bearing Windsor Group in their respective outcrop areas. In addition, each of these members is distinctly thicker than associated Upper Windsor members. Lithologically, no similarity exists between these members.

The presence of rugose corals in this carbonate member is of considerable importance for regional correlation. In the Windsor Group of the type area and in the Shubenacadie and Musquodoboit Basins they are known from only the Kennetcook (E subzone) and Herbert River (C subzone) Limestone Members within the Upper Windsor. They are rare in the B macrofaunal subzone (Lower Windsor), but are known to occur in the Musquodoboit Basin within the Ryan Brook Limestone Member of Giles and Boehner (1979) in a single outcrop and in several diamond-drill cores. Thus, rugose corals are known regionally from only three Windsor limestone members. Moore and Ryan (1976) show that the rugose coral assemblages of the C and E macrofaunal subzones are distinct and useful for regional biostratigraphic correlation.

Studies of Foraminifera (Mamet, 1970), conodonts (von Bitter, 1976), palynomorphs (Utting, 1978, 1979) as well as macrofauna (Bell, 1929, and Moore and Ryan, 1976) clearly support the contention that faunal and microfloral zonations can readily differentiate the Lower from the Upper Windsor (Figure 4). The choice of correlative possibilities is therefore narrowed to the Upper Windsor to which the E_1 is clearly assigned by Utting (1978, 1979), von Bitter (1976) and Mamet (1970). Furthermore, the work of Mamet (1970) indicates that both the Kennetcook and E_1 limestone members occur at the top of the Upper Windsor in biostratigraphic zonation as well as in lithostratigraphic position, whereas the Herbert River Limestone Member lies at the base of the Upper Windsor using comparable criteria.

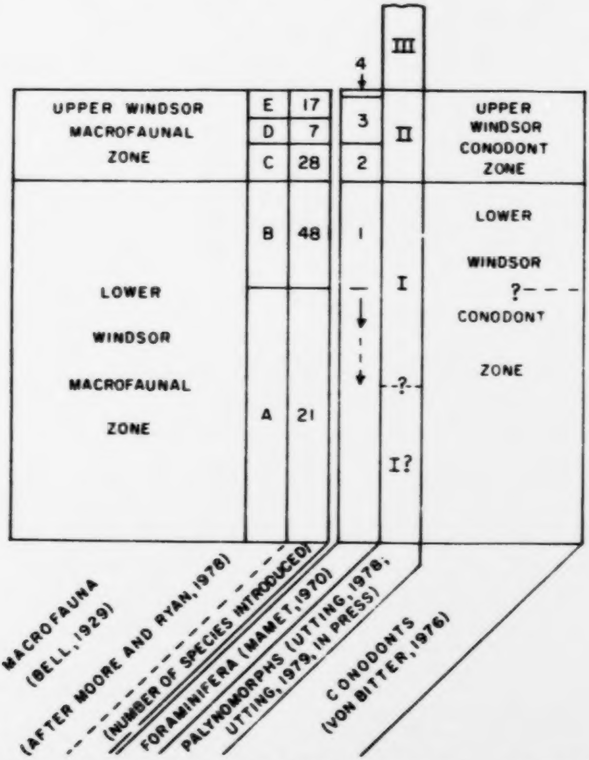
UPPER WINDSOR MACROFAUNAL ZONE
LOWER WINDSOR MACROFAUNAL ZONE
E
D
C
B
A
17
7
28
48
21
4
3
2
1
III
II
I
-?-
I?
UPPER WINDSOR CONODONT ZONE
LOWER WINDSOR CONODONT ZONE
?
MACROFAUNA (BELL, 1929)
(AFTER MOORE AND RYAN, 1976)
(NUMBER OF SPECIES INTRODUCED)
FORAMINIFERA (MAMET, 1970)
PALYNOMORPHS (UTTING, 1978; UTTING, 1979, IN PRESS)
CONODONTS (VON BITTER, 1976)

Figure 4. Biostratigraphic zonation of the Windsor Group in Nova Scotia. Note that the base of the Upper Windsor Macrofaunal Zone marks a biostratigraphic boundary reflected in each major field of micropaleontology.

It appears, therefore, that Sage's (1954) correlation of the E_1 with the Kennetcook Limestone Member is in accord with micropaleontological data. Supporting macrofaunal evidence is provided by the occurrence of rugose corals in the E_1 of the Pomquet River section. These biostratigraphic data suggest that facies transition between the E_1 and the Kennetcook may occur within the so-called Antigonish Basin (Figure 1), probably in its western and southwestern parts.

The use of rugose corals in the Windsor Group for purposes of biostratigraphic correlation is supported by this conclusion. Time and further study will continue to test this use. It is of considerable interest in this respect to note that at three localities, rugose corals including *Dibunophyllum lambii* have been collected from talus blocks derived from limestone assigned using lithologic criteria to Sage's (1954) C_1 limestone. Correlation of the C_1 with the Herbert River Limestone Member is suggested by the coral species, supporting Sage's (1954) and Stacey's (1953) original correlations based on other macrofaunal elements. Location of this diagnostic coral species in C_1 outcrop has not yet been possible.

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ALGAL MOUNDS AT NORTHEAST MABOU, CAPE BRETON ISLAND

P. S. Giles

INTRODUCTION

Two prominent mounds comprising massive limestone of predominantly algal origin occur on the southern flank of the Mabou Highlands at Northeast Mabou (Figure 1). Associated strata include sandstone and shale with lesser conglomerate and minor oolitic limestone. The mounds have been variously interpreted as 1) outliers of basal Windsor strata surrounded by older Horton Group beds (Norman, 1935); 2) basal Windsor strata unconformable upon older Horton strata and flanked and overlain by terrigenous rocks of the lower part of the Windsor Group (Phinney, 1956); and 3) limestone deposits assigned to the Horton Group (Bell, 1958). The recognition of complex carbonate banks at the base of the Windsor Group in central-mainland Nova Scotia in the Gays River Formation (Boehner, 1977; Giles, et al., 1979; Giles and Boehner, 1979) suggested that mounds at Northeast Mabou might be stratigraphically equivalent and therefore of current interest for base metal exploration.

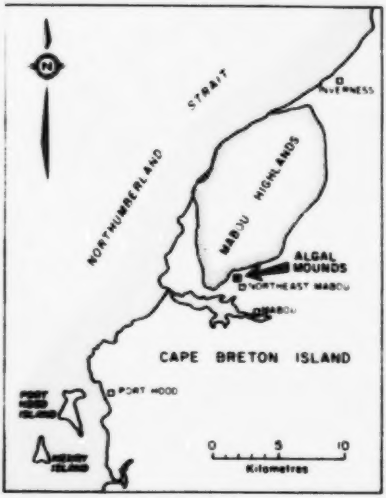

Figure 1. Location map.

Data for this study were provided by two diamond-drill cores which were obtained by Shea and Murray (1967) in their study of limestone deposits in Cape Breton Island. Approximately thirty petrographic thin sections were cut from the core of hole number 1 drilled at Northeast Mabou (Shea and Murray, 1967), here termed NEMB-1. The thin sections are distributed at regular intervals over the 13 m of limestone in the core.

GEOLOGICAL SETTING

The Mabou Highlands is an ellipetical upland area approximately 15 km in length and 9 km in width, trending northeasterly from Mabou Inlet to the town of Inverness (Figure 1) along the coast of Inverness County, Cape Breton Island.

The uplands are composed of Precambrian and Early Paleozoic strata of varying character (Norman, 1935; Keppie, 1979). Carboniferous rocks flank the Highlands, and include strata assigned to the Horton and Windsor Groups, as well as younger Carboniferous rocks (Norman, 1935; Phinney, 1956). The Carboniferous rocks were depicted by Norman (1935) as resting unconformably upon older rocks, and in part, faulted against older strata.

The limestone mounds at Northeast Mabou form pronounced knolls (Phinney, 1956) projecting tens of metres above associated strata. Phinney mapped in detail the area of the mounds, and showed that the mounds were flanked and overlain by sandstones and shales with minor limestone in thin beds, at least one of which was reported to contain fossil shells (?marine). The mounds were reported by Phinney (1956) to be unconformable upon sandstones and conglomerates, a small thickness of which separated them from the adjacent pre-Carboniferous rocks. Phinney's observations clearly refute Norman's (1935) interpretation of the mounds as basal Windsor outliers, resting upon and surrounded by older (Horton) strata. Instead, the mounds form part of a mixed carbonate-siliciclastic succession.

PETROGRAPHY OF THE ALGAL MOUNDS

In hand specimen and in core samples, the mounds are dominated by vaguely stratified to massive limestone, mottled with pale grey patches, but typically medium grey-brown in colour. Examination of petrographic thin sections indicates an algal origin for the limestone in the mounds (Figures 2, 3, and 4). Characteristically, tubules can be seen in a variety of orientations within massive, mottled patches. In some thin sections, a parallel arrangement of tubules imparts a distinct fabric to the limestone. More typically, a clotted, botryoidal mass results from the very irregular growth orientation of the algal tubules. Clear equant mosaic calcite cement may comprise up to 40% of the algal masses, resulting in a small-scale mottled appearance (Figure 2).

Explanation of Figure 2

Complex textures typical of the algal mound. Note numerous fine algal tubules in right-centre photograph. The initial porosity was very high, but is now completely filled by mosaic calcite cement (white) and in part by detrital grains and fine grained (dark) peloidal limestone and micritic limestone. Multiple generations of calcite crusts are indicated clearly by discontinuity in fine irregular laminations and by the incorporation of fine grained sediment within the crusts. Peloidal carbonate is vaguely shown beneath the laminated crust in the lower-central portion of the photograph. Note that voids remained after formation of the fibrous crusts, later partially filled with finely crystalline mud which formed miniscus cement (MC), subsequently filled with clear mosaic calcite cement. Sample NEMB-1; depth 12.3 feet (3.8 m). Printed from the thin section. The black bar is 2 mm in length.

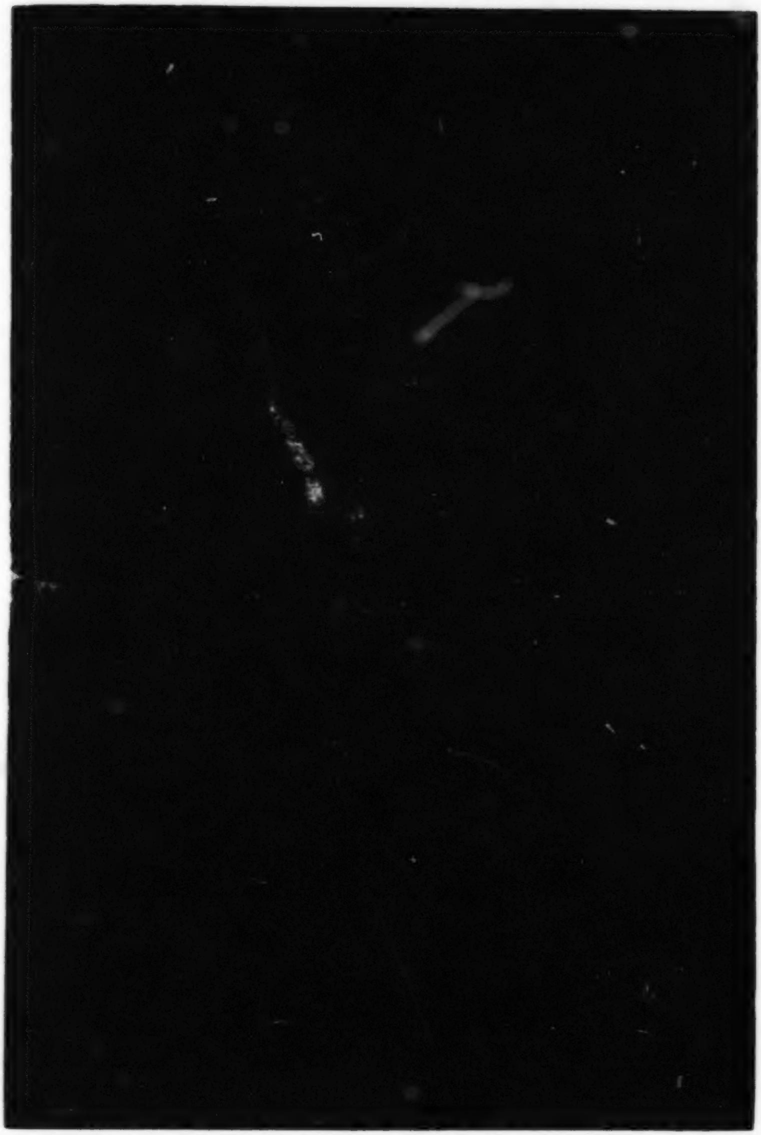

Figure 2. Algal limestone and laminar calcite crusts typical of the algal mound at Northeast Mabou.

A second rock type, subordinate in amount to the mottled algal limestone, but intimately associated throughout the vertical profile provided by diamond-drill core NEMB-1, comprises laminated peloidal-pseudoolitic limestone (Figure 4). The peloids and pseudooids are typically oblate or spherical and average less than 0.5 mm in diameter. Micritic limestone comprises the matrix. This peloidal-pseudoolitic limestone is often restricted to quite obvious cavities (Figures 3 and 4). In the lower parts of the mound, restriction to this mode of occurrence is less apparent, although the scale of study (thin sections) hampers the determination of gross relationships.

Occurring throughout the mound, in intimate association with both mottled algal limestone and laminated peloidal-pseudoolitic limestone, are complex laminar masses of coarsely fibrous, length-slow calcite (Figures 2, 3, and 4). Lamination is typically indicated by thin dark lines which are striking at low magnification, but fuzzy and ill-defined at higher magnification. Continuity of individual laminae is variable. Laminae typically number 7-10 per millimetre. Commonly, laminae in convex upwards masses butt abruptly, and at a high angle, against adjacent laminar masses. Laminar fibrous calcite is common in cavities within the algal mound, and is preferentially located in the lower portions of these cavities. Thinner zones of laminar calcite also occur on the walls (Figure 4) and the roofs (Figure 3) of cavities, where dripstone morphologies are apparent. The laminar calcite masses formed concurrently with deposition of peloidal and pseudoolitic limestone in cavities in the mound, as indicated by intimate interlamination of these rock types (Figure 4).

Similar fibrous length-slow calcite occurs in irregular patches within the algal limestone, where it forms radial, concentrically laminated encrustations around individual algal tubules.

Explanation of Figure 3

Impure limestone and conglomeratic limestone (A) termed marl by Phinney (1956) in exposures north of the Mabou Highlands. These rocks rest irregularly on top of the algal mound at Northeast Mabou and also form late-stage cavity fillings within large open spaces in the mound. Note the polymictic character in A with a large fragment of laminar crust (arrow) and abundant admixed terrigenous detritus.

Photograph B illustrates clearly the algal origin of the mound and the composite cavity-filling processes common in the mound. Compare the coarsest peloidal material in the lower part of the cavity with similar material in Figures 4A and 4B. Note the complex encrustations on the upper, overhanging portion of the cavity. Compare with the more regular laminated crust which occurs in the lower-right portions of the photograph. Sample NEMB-1; depth 23.2 feet (7.1 m). Printed from the thin section. The black bar is 2 mm in length.

Figure 3. Impure limestone and conglomeratic limestone which overlies the algal mound and partially fills open spaces within the mound.

A fourth rock type which occurs in the uppermost parts of the limestone mounds, and which overlies the mound proper in diamond-drill core NEMB-1, consists of limestone conglomerate (Figure 3A). Clasts include pieces of the laminar calcite described above, as well as mottled algal limestone in which algal tubules are clearly visible and which appear to have been derived from the mound itself. Quartz sand and silt are common constituents. In Figure 3B, fine grained limestone conglomerate forms a late-stage geopetal filling in a relatively small cavity in the upper part of the mound.

AGE OF THE ALGAL MOUNDS

Calcareous algae noted in a single thin section near the top of the mound at Northeast Mabou have been identified by the writer as *Kamaenella* sp., *Litostroma* sp., *Issinella* sp. and *Kamaena* sp., all of which have been reported from Visean (Windsor equivalent) rocks from the Newfoundland Shelf (Jansa, et al., 1978). Possible macrofaunal confirmation of Windsor equivalence includes the presence of a single small fragment of *Paraconularia* sp. in diamond-drill core near the top of the mound.

Palynomorphs have been successfully recovered from dark grey sandy shale immediately beneath the algal mound in diamond-drill core NEMB-1. These spores are most similar to, and probably assignable to, Assembledge Zone 1 (Utting, 1978, 1979) of the Windsor Group (S. Barss, personal communication, 1979). Utting (1979) believed that his Assemblage Zone I contained palynomorphs of Dinantian age, not older than the Arundian Stage of George, et al. (1976) i.e. Middle Visean.

In summary, the biostratigraphic data indicate a Visean age for the algal mounds and suggest time-equivalence with strata of the lower part of the Windsor Group.

Explanation of Figure 4

A: Laminated peloidal and pseudoolitic limestone of the typical Macumber Formation showing characteristic graded laminae. Note the pale outer rim which encircles most of the larger peloids. Sample provided by Dr. P. E. Schenk from his personal collection. Locality 201.

B: Detail of wall and floor of a cavity in the algal mound at Northeast Mabou. Note the close similarity of the peloidal sedimentary fill in B to the peloidal sediment in A, in size, shape, sorting, and in the apparent pseudoolitic coatings on the larger peloids. Finely pelletal layers compare with similar material dispersed throughout A. Note also the thinly laminated fibrous calcite crusts which line the cavity. Multiple generations are clearly indicated by the major discontinuities at X and Y and by interlayering with the peloidal limestone cavity fill. Note that peloids are scattered randomly throughout the thickest laminar crust flooring the cavity in left-centre photograph. Note also that the thin laminar crust at C passes continuously from the cavity wall to the cavity floor. The complex morphology of the laminar crust in the upper-centre parts of the photograph is suggestive of dripstone origin. Sample from diamond-drill core NEMB-1; depth 24.3 feet (8.4 m). Printed from the thin section. The black bar is 2 mm in length.

Figure 4. Peloidal limestone of the lower Macumber Formation compared with peloidal cavity fillings in the algal mound at Northeast Mabou.

DISCUSSION

Regional Correlation and Paleogeographic Implications

Biostratigraphic correlation of the algal mounds at Northeast Mabou with the Lower Windsor faunal zone is reasonably substantiated, thus refuting Bell's (1958) assignment of these rocks to the Horton Group. Due to the limited fauna and flora of the mounds, more specific correlation with Windsor strata elsewhere must also utilize lithostratigraphic evidence provided by rock units which comprise and flank the mounds. Within the Lower Windsor faunal zone, possible mound-correlative rock units include the Macumber and Gays River Formations at the base of the Windsor Group, and several mid-Windsor carbonate members assigned elsewhere to the MacDonald Road Formation (Giles and Boehner, 1979). The correlation favoured here, is with the Macumber and Gays River Formations, and accords with the earlier conclusions of both Norman (1935) and Phinney (1956). The arguments for this interpretation are summarized below.

Because faunal and floral constituents of the mounds are subject to paleoenvironmental controls as yet not regionally assessed, the nature of the strata which flank the mounds is more pertinent to regional correlation. Nevertheless, the general organic character of the mounds may be significant. Those at Northeast Mabou are dominated by algae, the growth of which largely controlled mound development. In contrast, the organic components of mid-Windsor mounds consist primarily of brachiopods with lesser molluscs and bryozoans. These mid-Windsor mounds are often coquinoid in nature. Complex organic banks (mounds) in the Gays River Formation are intermediate in character with a strong algal component, as well as a diverse macrofauna dominated by molluscs and bryozoans (Giles, et al., 1979). The strong algal influence in Gays River mounds is a characteristic shared with the mounds at Northeast Mabou.

The algal mounds at Northeast Mabou are coeval with peloidal and pseudoolitic carbonate rocks which are presumed to flank them. Comparison of these rocks with typical Macumber peloidal laminites (Figure 4) shows a distinct similarity and is the strongest lithologic evidence for correlation with the Macumber Formation. It is important to note that, although Gays River Formation mounds are immediately flanked by thinly stratified, sparsely fossiliferous carbonate rocks, these flanking rocks are also interstratified and coeval with peloidal carbonate beds of Macumber lithology (Giles, et al., 1979). Mid-Windsor coquinoid mounds, in contrast, pass laterally into thinly interstratified carbonate rocks and dark grey, calcareous marine shales (Giles and Boehner, 1979).

Strata which overlie the algal mounds at Northeast Mabou may ultimately confirm the correlative position of the mounds. These rocks were not examined during this study. It is, however, intriguing to note that a succession of sandstone and shales with thin oolitic limestone beds was described by Phinney (1956) in this stratigraphic position. These strata seem broadly similar to the Meaghers Grant Formation which interfingers with evaporites of the Carrolls Corner Formation (Giles and Boehner, 1979) in a basinward direction.

If correlation of Northeast Mabou Windsor strata with the Gays River - Macumber and Meaghers Grant Formations is tentatively accepted, then it is reasonable to invoke the paleogeographic model first proposed by Boehner (1977), and to suggest that the Mabou Highlands area was a positive paleotopographic feature in the Middle Visean, thereby explaining a) the development of biogenic mounds on its flanks, and b) its existence as a detrital source during periods of lowered sea level. This paleogeographic setting suggests in turn that additional examples of biogenic mounds should exist in the vicinity of the Mabou Highlands.

Alternatively, one might also speculate that the Mabou Highlands area was uplifted subsequent to initial Windsor deposition, yielding the limestone conglomerate and younger detrital clastic strata which overlie the mound. This alternative model is important to consider, because its implications include a) early Middle Visean tectonic activity, and b) the development of biogenic mounds on a Horton (?) substrait in areas typified by well developed Macumber lithosomes. The algal mounds, in this model, could be distributed over a broad area as pinnacle or patch "reef", independent of the presence and distribution of paleotopographic highs within the major Visean sedimentary basins in Nova Scotia. In order to test this hypothesis, assessment of the Macumber lithosomes throughout western Cape Breton Island should be undertaken. Such a broad distribution could be of considerable importance in governing exploration models applied to the Windsor Group in the search for base metals as well as oil or natural gas.

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WINDSOR GROUP STRATIGRAPHY AND PALEOGEOGRAPHY: PROJECT ACTIVITIES 1979-80

P. S. Giles

ANTIGONISH BASIN

Geological mapping continued in the Antigonish Basin (see Boehner, this volume) for the second summer. All available diamond-drill core in that area was logged by R. C. Boehner during the 1979 field season. The resulting data are being used to establish the stratigraphic succession for the Windsor Group in that Basin. Subsurface data are not abundant in the Antigonish Basin. In addition, complex facies variation is indicated by anomalous rock units, dated as Windsor-equivalent using spores. The succession is only in part comparable with better understood successions (e.g. Shubenacadie, Musquodoboit, Windsor type area and Pictou County areas). Therefore, until such time as more subsurface data are generated, some problems may remain unresolved.

Some of the complexity in the stratigraphic succession of the Windsor Group in the Antigonish Basin appears to be related to large scale low angle faults which result in juxtaposition of Upper Windsor and post-Windsor strata on lowermost Windsor salt and anhydrite. Within the thrust sheets (? nappes), carbonate marker beds can be recognized and traced at surface, but are demonstrably absent in the subsurface in downdip directions. A large area east of Antigonish Harbour appears to be characterized by major structures of this type.

AREAS PERIPHERAL TO THE ANTIGONISH BASIN

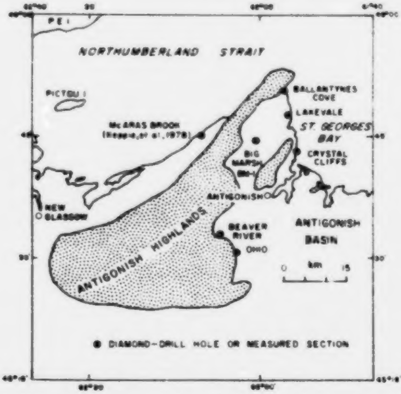
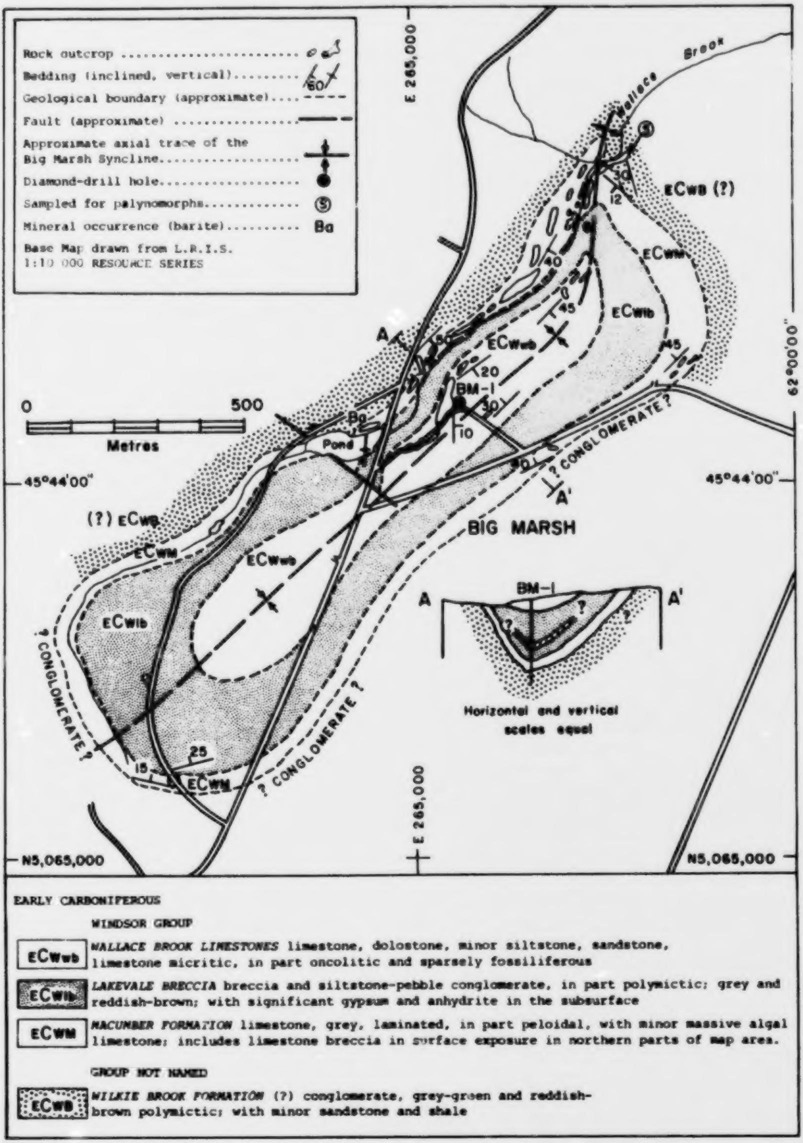


Figure 1. Location map showing the Antigonish Highlands bordered to the east by the Antigonish Basin.

Areas peripheral to the Antigonish Basin proper (Figure 1) were examined in detail by the writer in an attempt to expand Boehner's results. Maps of the Big Marsh and Lakevale Synclines were prepared (Figures 2 and 3) and the rock units in these areas described. Because these rock units are atypical for the Windsor Group, additional data were obtained from the southwestern extremities of the Antigonish Basin and from the Crystal Cliffs section north of the town of Antigonish (see Boehner, this volume) for purposes of comparison.


Rock outcrop
Bedding (inclined, vertical)
60
Geological boundary (approximate)
Fault (approximate)
Approximate axial trace of the Big Marsh Syncline
Diamond-drill hole
Sampled for palynomorphs
Mineral occurrence (barite)
Ba
Base Map drawn from L.R.I.S. 1:10 000 RESOURCE SERIES
E 265,000
Wallace Brook
ECWB (?)
ECWM
ECWlb
ECWwb
30
12
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BM-1
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ECWlb
BIG MARSH
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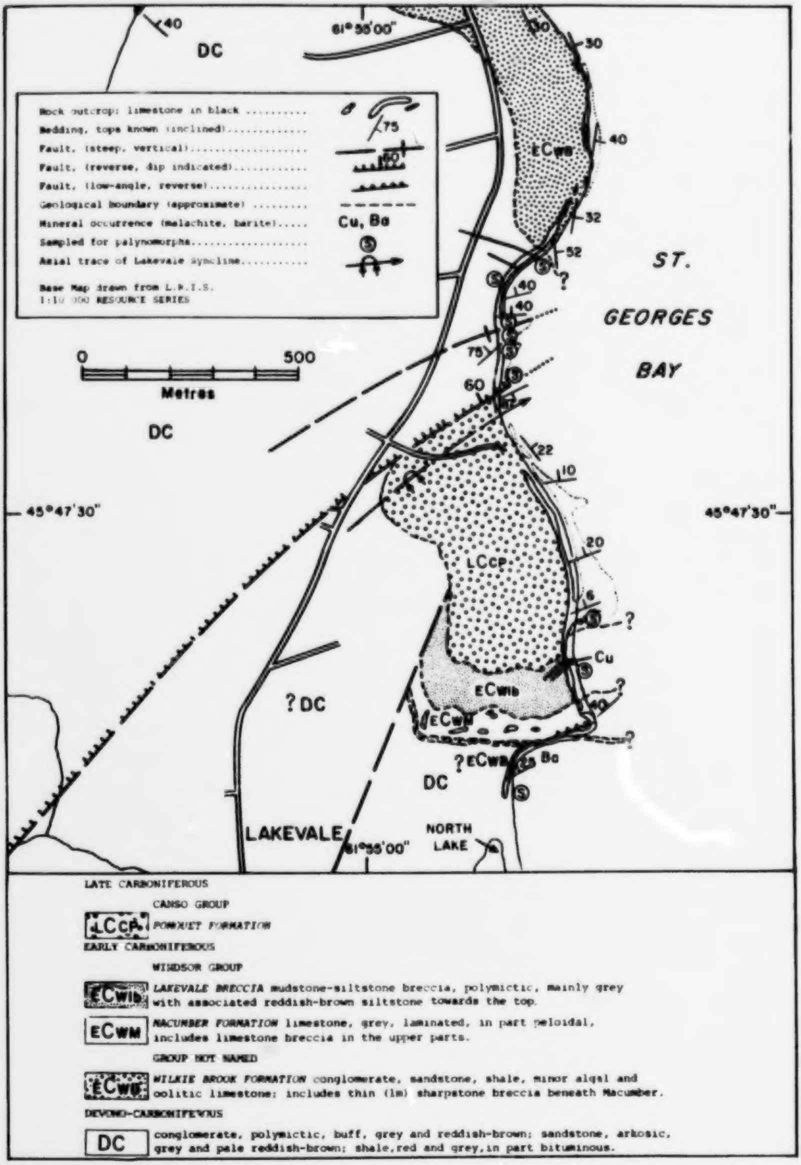
Horizontal and vertical scales equal
? CONGLOMERATE ?
? CONGLOMERATE ?
25
15
ECWM
E 265,000
N5,065,000
N5,065,000
EARLY CARBONIFEROUS
WINDSOR GROUP
ECWwb
WALLACE BROOK LIMESTONES limestone, dolostone, minor siltstone, sandstone, limestone micritic, in part oncolitic and sparsely fossiliferous
ECWlb
LAKEVALE BRECCIA breccia and siltstone-pebble conglomerate, in part polymictic; grey and reddish-brown; with significant gypsum and anhydrite in the subsurface
ECWM
MACUMBER FORMATION limestone, grey, laminated, in part peloidal, with minor massive algal limestone; includes limestone breccia in surface exposure in northern parts of map area.
GROUP NOT NAMED
ECWB
WILKIE BROOK FORMATION (?) conglomerate, grey-green and reddish-brown polymictic; with minor sandstone and shale

Figure 2. Geological map of the Big Marsh Syncline.


61°55'00"
DC
ST.
GEORGES
BAY
ECwb
ECwlb
ECwm
LCcp
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Cu
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LAKEVALE
NORTH
LAKE
45°47'30"
45°47'30"
30
40
32
52
40
40
75
60
22
10
20
6
40
?
0
500
Metres
Rock outcrop: limestone in black ....
Bedding, tops known (inclined)..............
Fault, (steep, vertical)....................
Fault, (reverse, dip indicated).............
Fault, (low-angle, reverse).................
Geological boundary (approximate) ....
Mineral occurrence (malachite, barite).....
Cu, Ba
Sampled for palynomorphs...................
S
Axial trace of Lakevale Syncline...........
Base Map drawn from L.R.I.S.
1:10 000 RESOURCE SERIES
LATE CARBONIFEROUS
CANSO GROUP
LCcp
POMQUET FORMATION
EARLY CARBONIFEROUS
WINDSOR GROUP
ECwlb
LAKEVALE BRECCIA mudstone-siltstone breccia, polymictic, mainly grey with associated reddish-brown siltstone towards the top.
ECwm
MACUMBER FORMATION limestone, grey, laminated, in part peloidal, includes limestone breccia in the upper parts.
GROUP NOT NAMED
ECwb
WILKIE BROOK FORMATION conglomerate, sandstone, shale, minor algal and oolitic limestone; includes thin (1m) sharpstone breccia beneath Macumber.
DEVONO-CARBONIFEROUS
DC
conglomerate, polymictic, buff, grey and reddish-brown; sandstone, arkosic, grey and pale reddish-brown; shale,red and grey,in part bituminous.

Figure 3. Geological map of the Lakevale section, Antigonish County.

In these peripheral areas, either the Macumber or the Gays River Formations may locally lie at the base of the Windsor Group. The latter Formation is well exposed in the Southside Harbour area where it fringes granitic knolls. Recently, equivalents of the Gays River Formation have been drilled in the Ohio area (Figure 1). However, in the Antigonish Basin and in areas peripheral to the Basin, the laminated Macumber Formation is the typical basal Windsor rock unit.

Overlying the basal carbonate rocks in areas examined at Big Marsh, Lakevale, and Ohio, is a succession of paraconglomerate, with associated gypsum and minor limestone, over 100 m in thickness. This major rock unit outcrops sparingly at Big Marsh where it was, however, cored in its entirety in diamond-drill hole BM-1 (Figure 2). It is well exposed on the shore at Lakevale (Figure 3). In the Ohio area, drilling has sporadically recovered rocks similar to those at Big Marsh and Lakevale. However, closely adjacent drillholes have cored sections of anhydrite and gypsum which appear correlative with the Carrolls Corner Formation of Giles and Boehner (1979).

The paraconglomerate unit, termed the Lakevale breccia (informal) is variegated reddish-brown and greenish-grey in colour, polymictic in part, but dominated by siltstone clasts in a sandy silt matrix. Stratification is typically obscure although several intervals in the core of BM-1 (Figure 2) are well stratified and in some instances display graded bedding. Clasts within the paraconglomerate are often rimmed by material of contrasting colour. This same alteration feature has been noted in probable mid-Windsor strata a short distance east of Ohio.

The age and origin of the Lakevale breccia are the subject of continuing research by project staff. At this time, an assignment to the lower part of the Windsor Group is indicated by palynomorphs recovered from the breccia at Lakevale (M. S. Barss, personal communication, 1979). However, several possible hypotheses regarding its regionally correlative position remain. These include:

a) the breccia represents a terrigenous lateral facies of the thick sulphate deposits which occur near the base of the Windsor Group; this hypothesis suggests possible analogy with the documented relationships between the Meaghers Grant and Carrolls Corner Formations in the southern part of the Musquodoboit Basin (Giles and Boehner, 1979).

b) the breccia records deposition late in the first major (depositional) cycle in the Windsor Group (Giles, in press) and postdates the major salt and anhydrite deposits low in the Windsor; some support for this hypothesis is found in the northeastern extremities of the Shubenacadie Basin where a locally distributed red siltstone breccia containing detrital blocks of anhydrite, rests upon lower Windsor salt. This silt-anhydrite breccia is in turn overlain disconformably by basal strata of the mid-Windsor MacDonald Road Formation (Giles and Boehner, 1979) in the Shubenacadie Basin.

c) the breccia is laterally equivalent to part or all of the MacDonald Road Formation equivalent in the Antigonish Basin; supporting evidence includes the presence of similar strata within cyclic carbonate-evaporite-siltstone sequences in parts of the Antigonish Basin.

In hypotheses b) and c) above, it is both possible and probable that the breccia was in part deposited in karstic solution trenches preferentially developed at the contact between the basal carbonate and the overlying evaporites. Deposition in these paleotopographic features would explain the very abrupt lateral changes in strata drilled in the Ohio area.

Although the precise stratigraphic position and mode of origin remain in doubt, the age of the breccia cannot be younger than that of the Pomquet Formation (Namurian) dated at Lakevale (M. S. Barss, personal communication, 1979). In the Lakevale section the Pomquet Formation lies unconformably upon the Lakevale breccia (Figure 3).

STRAIT OF CANSO AREA

Project staff attempted to gain an understanding of the Windsor Group in the McIntyre Lake area of Cape Breton Island using diamond-drill core obtained by Home Oil (and others). This study is incomplete although approximately 8000 feet (2440 m) of core have been logged in detail. Subsurface studies have revealed severe structural complexities in the McIntyre Lake area involving repetition by folds and reverse faults. It is significant that many of the carbonate units observed in diamond-drill core are probably Upper Windsor beds, although the succession cored is dominated by halite. Project staff will continue work in this area in 1980-81.

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THE NEW GEOLOGICAL MAP OF THE COBEQUID HIGHLANDS, NOVA SCOTIA

H. V. Donohoe and P. I. Wallace

INTRODUCTION

The new geological map of the Cobequid Highlands is shown in a generalized form in Figure 1. The map and legend will be placed on open file early in 1980; later in 1980 the map will be published with the memoir entitled Geology of the Cobequid Highlands, Nova Scotia.

In the paragraphs which follow, a brief description of stratigraphy, plutonic rocks, and faulting is presented to highlight recent advances in understanding.

STRATIGRAPHY

Precambrian

Crystalline Proterozoic rocks outcrop on the southern side of the Cobequid Highlands in two locations. The Mt. Thom complex (map unit 1 in Figure 1) consists of biotite-garnet-microcline gneisses, amphibolite and granite gneiss. In the central part of the Highlands the Bass River Complex (map unit 2) is bound by the Londonderry and Rockland Brook Faults. This diverse unit comprises quartzites, biotite ± muscovite schists, basic metavolcanic rocks and hornblende-plagioclase-chlorite-quartz para- and/or ortho-gneisses. These rocks had been intruded by granitoid rocks which are now granite gneisses (map unit 3) and form distinct mapable entities. All of these crystalline rocks have been deformed at least three times and regionally metamorphosed to garnet grade.

Younger Proterozoic (Hadrynian) strata (map units 4, 5) outcrop north of the Rockland Brook Fault and appear to underlie most of the Cobequid Highlands at depth. These strata consist of the Jeffers and Warwick Mountain Formations and comprise meta-quartz wackes and volcanic wackes, meta-siltstone, basic metavolcanic rocks and minor marble. These Formations have been deformed twice and metamorphosed to greenschist facies. After the second deformation the Jeffers Formation was intruded by the Jeffers Brook Diorite (map unit 6). This pluton has been radiometrically dated using the K/Ar and Rb/Sr systems. Keppie and Smith (1978; after Wanless, 1973) reported the following K/Ar dates: for biotite 585 ± 23, 564 ± 22, 544 ± 22 and for hornblende 628 ± 28, 616 ± 28 Ma. A biotite separate yielded a Rb/Sr mineral isochron date of 541 ± 25 Ma (Cormier, 1979). The Jeffers and Warwick Mountain Formations are similar in lithology and age to other Hadrynian strata in Saint John, New Brunswick (Coldbrook Group; Alcock, 1938; Ruitenberg, et al., 1979) and southeastern Cape Breton Island (Fourchu Group; Murphy, 1977). Strata of probable equivalent age are found near Arisaig in the Antigonish Highlands (Georgeville Group; Murphy, et al., 1979).

The Bass River and Mt. Thom complexes are considered to be older than the Jeffers and Warwick Mountain Formations because the former are high-grade metamorphic rocks without any vestiges of sedi-

Legend for the Geological Map of the Cobequid Highlands

			STRATIFIED ROCKS		PLUTONIC ROCKS	
MESOZOIC	TRIASSIC TO JURASSIC		31	**FUNDY GROUP:** *undivided, quartz, lithic, wacke, siltstone, polymictic, conglomerate; basalt flows*		
PALEOZOIC	CARBONIFEROUS	Upper	30	**PICTOU GROUP:** *grey, red wacke, siltstone, conglomerate; coal*		
			29	**CUMBERLAND GROUP:** *grey, red siltstone, wacke; coal; red-brown conglomerate*		
			27 | 28	**RIVERSDALE GROUP:** *(28) BOSS POINT FM.: grey, red siltstone, lithic wacke; (27) PARRSBORO FM.: grey, red wacke, siltstone*		
			25 | 26	**CANSO GROUP:** *(26) LONDONDERRY FM.: green, grey quartz wacke, siltstone, shale; (25) WEST BAY FM. AND* **CANSO GROUP:** *grey, red, green siltstone, wacke, shale*		
		Lower	24	**WINDSOR GROUP:** *grey limestone, red, grey siltstone, shale*	23	*granite (syenogranite to alkali feldspar granite; granodiorite to monzogranite)*
			22	**HORTON GROUP:** *grey, red siltstone, quartz wacke, shale*		
	DEVONIAN TO CARBONIFEROUS		20 | 21	*(21) RAPID BROOK, GREVILLE RIVER FMS.: grey, tan siltstone, wacke, granite-clast, conglomerate; (20) NUTTBY FM.: grey, red lithic wacke, siltstone, shale; conglomerate*	19	*granite (monzogranite to alkali feldspar granite)*
					18	*diorite*
	DEVONIAN	Upper?	17	*FALLS FM.: red-brown polymictic conglomerate, lithic wacke*		
		Middle	16 | 15 | 14	**(16) FOUNTAIN LAKE GROUP:** *(15) DIAMOND BROOK FM.: basalt flows, red, grey siltstone; (14) BYERS BROOK FM.: tan rhyolitic, dacitic lava flows, ignimbrites, tuffs, grey siltstone*		
			13	*MURPHY BROOK FM.: black, grey siltstone, wacke, polymictic conglomerate*		
		Lower	12	*PORTAPIQUE RIVER FM.: red, green siltstone, quartz and lithic wacke*		
	SILURIAN	Lower to Upper	10 | 11	*(11) WILSON BROOK FM.: grey siltstone, quartz wacke, shale; red siltstone; granite-clast conglomerate; (10) EARLTOWN FM.: grey siltstone, wacke, calcareous siltstone; tan, green rhyolite flows, ignimbrites, ash-fall tuffs; (11A) unnamed black, grey siltstone, lappilli tuff; (11B) unnamed grey, tan, red siltstone,quartz arenite and wacke, granite clast polymictic conglomerate; may be younger*		
	CAMBRO-ORDOVICIAN				9	*McCALLUM SETTLEMENT GRANITE (syenogranite)*
	AGE UNKNOWN				7 | 8	*(8) granite (alkali feldspar granite, syenogranite) (7) diorite*
PROTEROZOIC	HADRYNIAN				6	*JEFFERS BROOK DIORITE*
			4 | 5	*(5) WARWICK MOUNTAIN AND (4) JEFFERS FMS.: green, grey basic meta-volcanic rocks, meta-tuff, meta-wacke; marble*		
	PRE-HADRYNIAN?				3	*granite gneiss*
			2	**BASS RIVER COMPLEX:** *biotite schist, quartzite, chlorite schist, gneiss*		
			1	**MT. THOM COMPLEX:** *biotite-garnet gneiss; granite gneiss; amphibolite*		

Figure 1. Generalized geological map of the Cobequid Highlands.

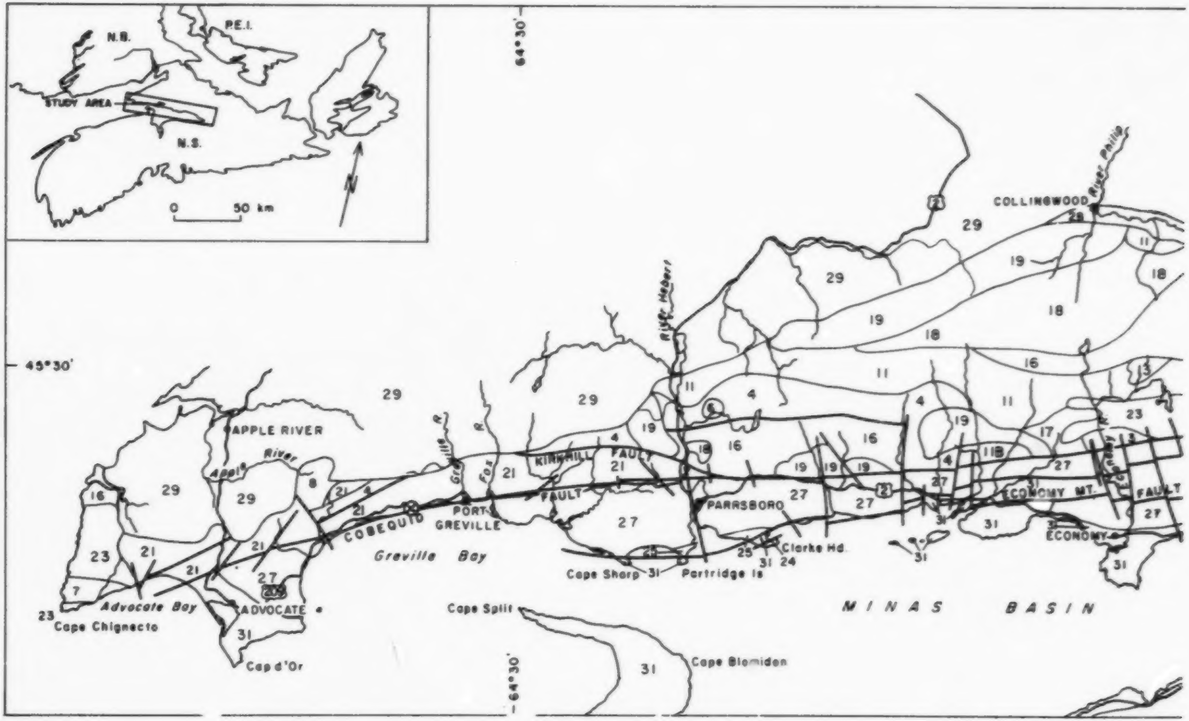

Figure 1. Continued (eastern half of map on following page).

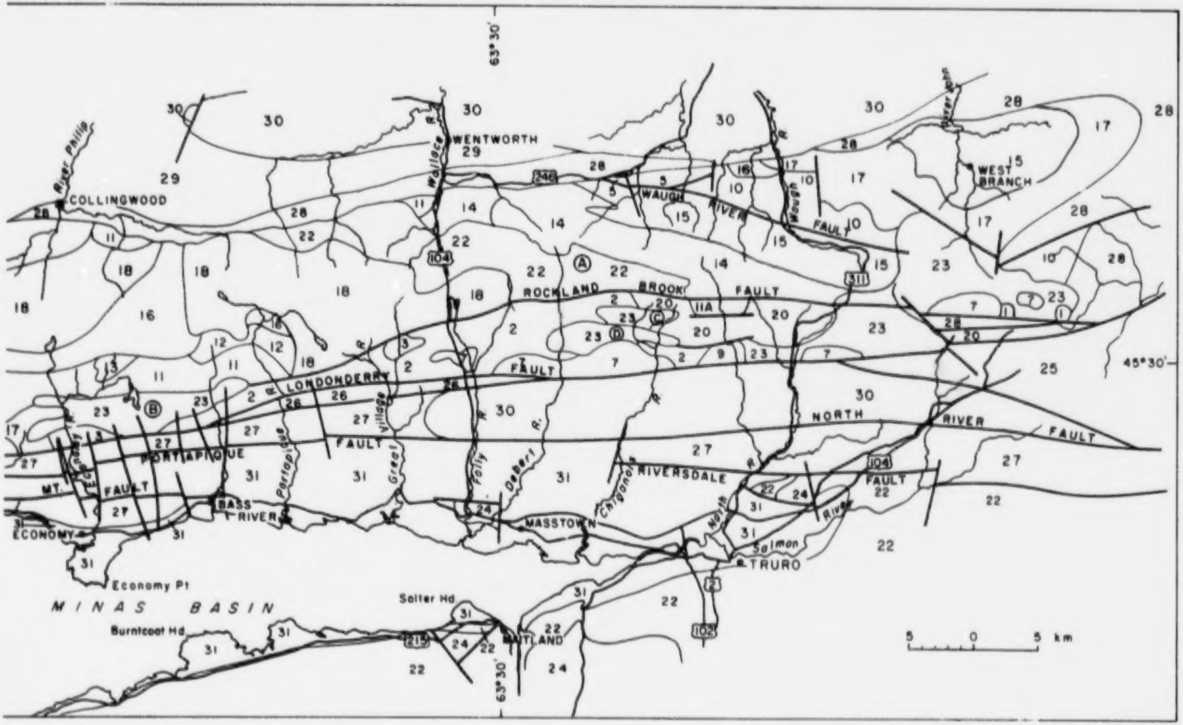

Figure 1. Continued.

mentary structure; the latter are low-grade metamorphic rocks with common sedimentary structures. The crystalline rocks have deformed and metamorphosed more than the Hadrynian strata.

Silurian

The oldest Paleozoic strata found in the Cobequid Highlands are the dark grey to black siltstones of map unit 11A south of the Rockland Brook Fault. A Middle to Late Ordovician age is indicated by the brachiopods (R. Neuman, personal communication, 1978) but the time span could be Middle Ordovician to Early Silurian. North of the Rockland Brook Fault the oldest strata are Llandoverian A2 (map unit 11). The central and eastern Cobequids are underlain by the Silurian aged Wilson Brook (map unit 11) and Earltown Formations (map unit 10). The Wilson Brook Formation is composed primarily of grey quartz wacke, siltstone and shale. Felsic volcanic rocks are found near the base and both felsic and mafic volcanic rocks are found in some areas near the top. The Earltown Formation is dominated by felsic volcanic rocks (flows, tuffs), but does have interbedded fossiliferous grey quartz wacke and siltstone. The Wilson Brook and Earltown Formations have been penetratively deformed resulting in the development of cleavage and folding.

Devonian

Deposition continued without a break into the Early Devonian (Donohoe and Wallace, 1979) with the deposition of the red-coloured Portapique River Formation (map unit 12). This Formation is gradational with the Wilson Brook Formation and is only exposed on the Bass and Portapique Rivers (Figure 1). Elsewhere it has been eroded.

Overlying the Wilson Brook Formation with disconformity is the Murphy Brook Formation (map unit 13). The black siltstones, interbedded with conglomerates, contain early Middle Devonian plant fossils (Kasper, personal communication, 1979). The Murphy Brook and Portapique River Formations have been penetratively deformed.

Unconformably overlying all of the Silurian to early Middle Devonian strata is a thick succession of felsic and mafic volcanic rocks named the Fountain Lake Group (map unit 16). In the eastern Highlands the Group is divisable into the older Byers Brook Formation and younger Diamond Brook Formation (map units 14, 15, respectively). The Group has been faulted, but not penetratively deformed.

The Late Devonian (or younger?) Falls Formation (map unit 17) unconformably overlies the other Paleozoic formations. It comprises a molasse deposit of red-brown polymictic conglomerate and wacke.

Devono-Carboniferous

The Nuttby Formation (map unit 20) located south of the Rockland Brook Fault was deposited in Late Devonian to Early Carboniferous time. It comprises red and grey siltstones, wackes, and polymictic conglomerates. At the western end of the Cobequid Highlands the Rapid Brook and Greville River Formations (map unit 21) are probably coeval with the Nuttby

Formation; however, the age of these two Formations is imprecisely known and they may be younger than Devonian. The Rapid Brook and Greville River Formations consist of grey and tan quartz and lithic wackes, siltstone and polymictic conglomerate.

Carboniferous

The youngest rock unit in the Cobequid Highlands is the Londonderry Formation (map unit 26). The Formation is situated between the Cobequid and Londonderry Faults and comprises grey and green quartz and feldspathic wackes and siltstones.

The Nuttby, Rapid Brook, Greville River and Londonderry Formations have been penetratively deformed. All were cleaved and folded during the Middle Carboniferous prior to the deposition of the Riversdale Group.

PLUTONIC ROCKS

Plutonic rocks in the Cobequid Highlands range in age from pre-Hadrian to Carboniferous; underlie about 40% of the Highlands' area; and form a bimodal suite of diorite and syenogranite. A few plutons are solely composed of intermediate compositions (granodiorite, monzogranite). When plutons are in fault contact with other strata, nonconformably overlain, and/or intruded by younger plutons, they are shown on Figure 1 as age unknown (map units 7, 8). Most plutons can be dated by either the age of the youngest formation intruded or by radiometric dating.

Pre-Devonian Plutons

The oldest recognized plutonic rocks are the granite gneisses (map unit 3) found in the Bass River Complex exposure area. These show intrusive relationships modified by strain and high metamorphic grade. Many of these granite gneiss bodies have layers of chlorite schist or amphibolite interleaved with the gneiss. The chlorite schist and amphibolite are interpreted as diabase dykes because several have remnant diabasic texture.

The two remaining pre-Devonian plutons are the Jeffers Brook Diorite and McCallum Settlement Granite. The Jeffers Brook Diorite intruded the Jeffers Formation after the strata were deformed twice. The diorite has been dated as Late Hadrynian to Early Cambrian as described previously. The McCallum Settlement Granite has been dated by the Rb/Sr system at 504 ± 27 Ma (Cormier, personal communication, 1979). The pluton comprises syenogranite.

Several plutons have unknown ages. The diorite plutons of map unit 7 are surrounded by younger granite and thus their relative ages to other stratigraphic units are not known. In the western Highlands, at the headwaters of the Apple River, a deformed granite pluton (map unit 8) is nonconformably overlain by the Cumberland Group and Rapid Brook/Greville River Formations and is in fault contact with the Jeffers Formation. No relative age can be determined.

Devonian to Carboniferous Plutons

Map units 18, 19 and 23 represent diorite and granite plutons which either intruded Middle Devonian or younger strata or have radiometric ages. The diorite plutons (map unit 18) are intruded by granite (map units 19, 23). The granite plutons are composed of alkali-feldspar granite to syenogranite. The pluton labelled D on Figure 1 is primarily composed of monzogranite and granodiorite. Several of the granite plutons are younger relative to others: pluton D intrudes pluton C; pluton A is cut by the Rockland Brook Fault which is intruded by pluton B. Radiometric dating reported by Cormier (1979) and Donohoe *in* Clarke, et al., (1979) confirms the existence of Carboniferous aged plutons.

FAULTING

Major east-west trending faults form the southern margin of the Cobequid Highlands. These faults isolate stratigraphic units which are generally distinct from adjacent units and have different structural histories from adjacent units. The Londonderry Formation (map unit 26 in Figure 1), of early Late Carboniferous age, is bound by the Cobequid and the Londonderry Faults. The fault block between the Londonderry and Rockland Brook Faults contains the Bass River complex (map unit 2) of pre-Hadrynian age, unnamed Late Ordovician-Early Silurian age strata (map unit 11A) and Late Devonian to Carboniferous age Nuttby Formation (map unit 20). North of the Rockland Brook Fault in the east there are no major east-west trending faults.

The faults named on the map (Figure 1) have had a complicated history of vertical and horizontal movement according to Donohoe and Wallace (1978). In Greville Bay a block of rhyolite (20 m x 100 m) is interpreted to have been moved from a previous position, northeast of Parrsboro in the Fountain Lake Group (map unit 16), to its present position (marked by "x" on Figure 1) 20 km west (Donohoe and Wallace, 1978). This movement is only a minimum and probably involves hundreds of kilometres of movement (Keppie, 1979). Along the Economy Mountain Fault, Fundy Group basalt (map unit 31) has been offset 3 km dextrally. Movement on the Rockland Brook Fault has produced a discontinuous mylonite zone which affects Early Carboniferous age granitic plutons (map unit 23); the timing of this is constrained by the deformation of pluton A on Figure 1 (post 331 ± 27 Ma; Cormier, 1979) in the east and the intrusion of the fault zone by pluton B (~315 ± 25 Ma; Cormier, personal communication, 1979) in the west. The age of this lateral movement would be approximately early Late Carboniferous time.

Dip-slip movement has occurred on all of the east-west faults either as a component of the strike-slip movement or as a separate movement. Conglomerates in rock units within the Cobequid Highlands (part of map unit 11; map units 11B, 13, 17, and 20) and adjacent to the Highlands (map units 28, 29, 30, 31) represent varying amounts of uplift (Donohoe and Wallace, 1978) from Devonian through Carboniferous to Triassic-Jurassic time.

The east-west trending faults are offset by three other systematic fault systems: northwest, northeast and north-south trending. On the north side of the Cobequid Highlands, the Boss Point Formation, Cumberland Group and Pictou Group contacts with older Paleozoic rocks in the Highlands have not been displaced; all faults have been overlain by deposition of these younger strata. On the southern margin of the Highlands younger strata are affected by movement on all three fault trends.

The stratigraphic relations suggest that northwest and northeast trending faults had movement on them during the interval of post-Greville River Formation to pre-Cumberland Group time. North-south trending faults offset all others and the Early Jurassic strata of the Fundy Group (map unit 31) indicating a post-Early Jurassic age of movement. Examination of the detailed 1:50,000 maps on open file suggest that the north-south trending faults have had several episodes of movement. This conclusion is supported by major offsets of stratigraphic units (Hadrynian juxtaposed against Silurian to Devonian strata) in the Highlands, but very little offset of the Carboniferous strata to the south or north.

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GEOPHYSICAL SURVEYS 1979-1980

P. S. Giles

No new airborne geophysical surveys were initiated during the fiscal year 1979-1980.

Release of high-sensitivity aeromagnetic total field and gradiometer maps of the Antigonish Highlands (Figure 1) is anticipated in February, 1980. High turbulence in the area at the time of initial flying necessitated considerable reflying and resulted in some delay in completion of the survey.

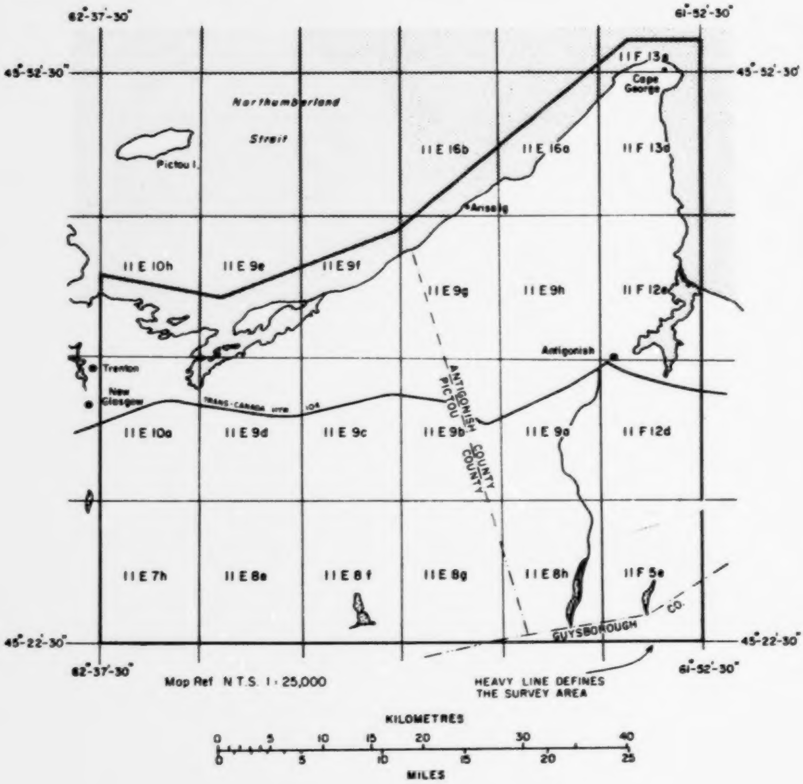

Figure 1. High resolution gradiometer survey, Antigonish-Pictou Highlands area, Nova Scotia.

The high-sensitivity aeromagnetic survey of northern Cape Breton Island is progressing satisfactorily with map preparation now in progress. Release of total field and (calculated) vertical gradient maps for the area (Figure 2) will be achieved prior to May, 1980.

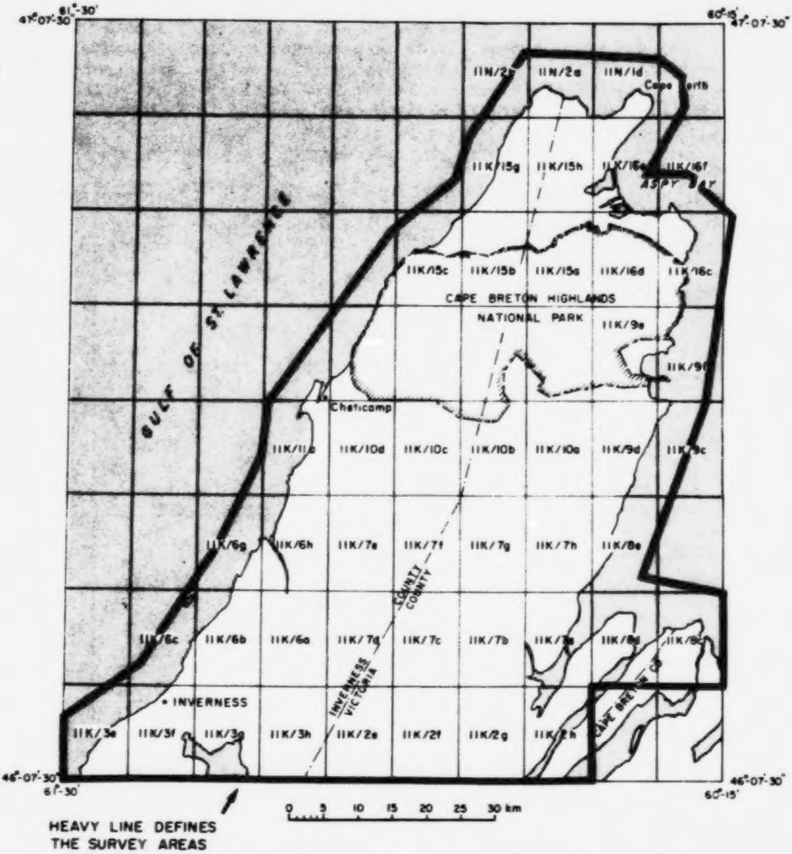

Figure 2. High-sensitivity aeromagnetic survey, northern Cape Breton Island, Nova Scotia.

The results of these surveys will provide direct assistance to geologists engaged in mapping programs which form an integral part of any comprehensive exploration program. Aeromagnetic surveys of this nature are particularly applicable in pre-Carboniferous terranes in Nova Scotia, as exemplified by gradiometer surveys presently available for parts of the Yarmouth area and in the area north of Halifax (see Nova Scotia Department of Mines, Report 77-1).

NEW RUBIDIUM/STRONTIUM AGES IN NOVA SCOTIA

R. F. CORMIER*

Over the past few years, Rb/Sr age data have been acquired in support of several projects of the Nova Scotia Department of Mines and Energy. Ages completed during 1979 are reported here. They are calculated using a decay constant of

$$\lambda(^{87}\mathrm{Rb}) = 1.42 \times 10^{-11}/\mathrm{yr}.$$

Isochrons were calculated using the York (1966) method with errors reported to the 95% confidence level, unless otherwise specified.

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PLEASANT HILLS PLUTON - INTERPRETATION

A total of eleven whole rock (WR) samples were analyzed; in addition, samples of potassic feldspar (KF) and quartz-plagioclase feldspar (QP) from six of these rocks were analyzed. When all of the whole rock and mineral data are plotted on an isochron diagram, as in Figure 1, there is seen to be considerable scatter among the points. Least-squares fitting and error calculations give an age of 315 ± 25 Ma with initial 87Sr/86Sr (R_o) of 0.7082 ± 0.0022. Two points (JS-75-61 WR and E05-4150 WR) were not used in the calculations.

Four of the samples for which feldspar data were obtained yield internally consistent whole rock-mineral isochrons that are essentially parallel to one another, but which have significantly different R_o values ranging from 0.7060 to 0.7105. These are shown in Figure 2. These four isochrons give ages of 312, 312, 311 and 305 Ma. The isochrons were drawn 'by eye' and meaningful error calculations are not really possible since each is based on only three points. However, the agreement among the isochrons of Figures 1 and 2 is very close.

I would interpret the scatter in Figure 1 as due to two effects: a) variations in the initial ratio 87Sr/86Sr within the original magma; and b) later incomplete closure of some of the rocks to movement of strontium and/or rubidium. The latter might be due to either primary processes (metamorphism, etc.) or to secondary, possibly weathering, processes.

I would conclude the age of the Pleasant Hills pluton to be 315 ± 25 Ma. Values of R_o in the original magma were variable between approximately 0.706 and 0.711.

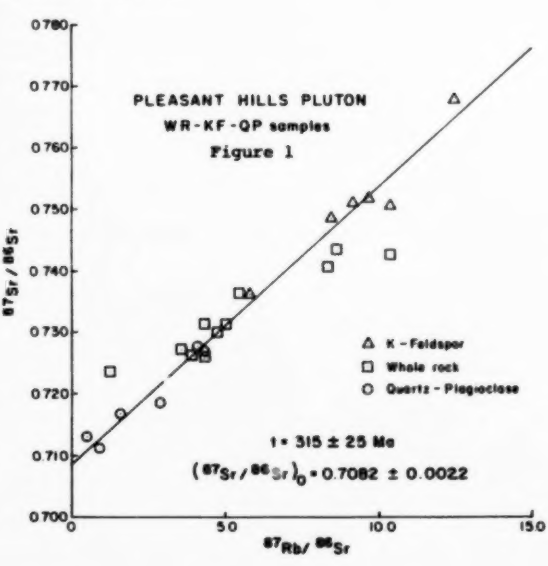
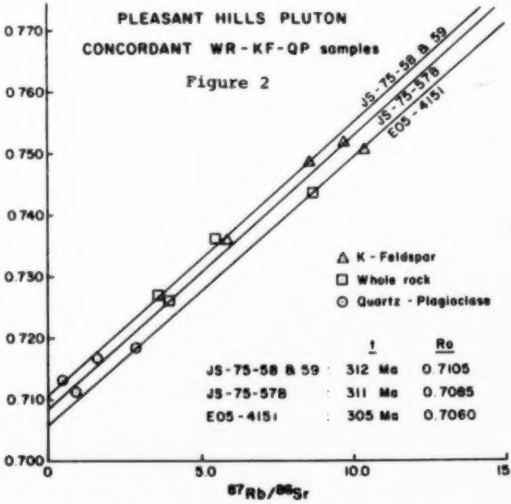


Figure 1

PLEASANT HILLS PLUTON - ANALYTICAL RESULTS

SAMPLE NUMBER	Rb (ppm)	Sr (ppm)	87Rb/86Sr	87Sr/86Sr
JS-75-55 WR	162	99.2	4.75	0.7300
JS-75-56 WR	149	101	4.28	0.7313
JS-75-60 WR	228	152	4.36	0.7261
JS-75-61 WR	79.1	186	1.23	0.7236
JS-75-57A WR	190	110	5.00	0.7310
JS-75-57B WR	154	115	3.89	0.7261
JS-75-57B KF	295	88.6	9.69	0.7517
JS-75-57B QP	16.9	52.6	0.930	0.7112
JS-75-58 WR	197	104	5.48	0.7360
JS-75-58 KF	276	94.0	8.53	0.7485
JS-75-58 QP	51.5	92.6	1.61	0.7167
JS-75-59 WR	188	152	3.59	0.7270
JS-75-59 KF	287	143	5.83	0.7360
JS-75-59 QP	65.2	380	0.497	0.7131
E05-4150 WR	228	63.5	10.4	0.7426
E05-4150 KF	326	76.2	12.5	0.7676
E05-4150 QP	70.0	46.8	4.34	0.7264
E05-4151 WR	185	62.2	8.61	0.7433
E05-4151 KF	260	72.5	10.4	0.7506
E05-4151 QP	47.6	47.7	2.89	0.7184
E05-4152 WR	175	61.1	8.33	0.7403
E05-4152 KF	231	73.0	9.19	0.7510
E05-4152 QP	72.3	51.3	4.09	0.7275



PLEASANT HILLS PLUTON

CONCORDANT WR-KF-QP samples

Figure 2

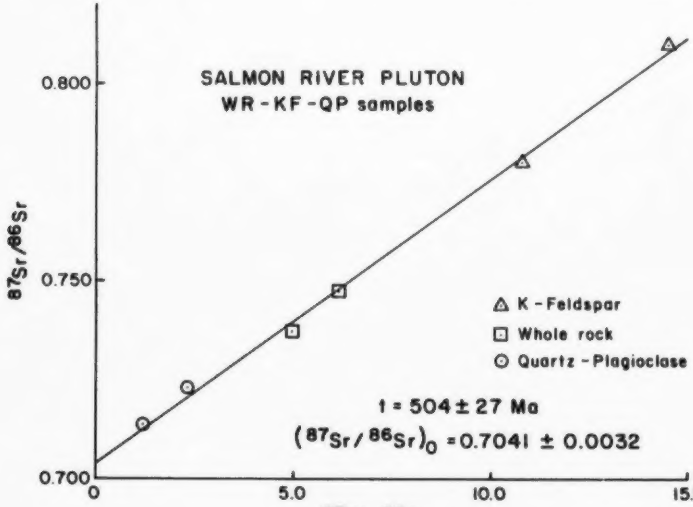
SALMON RIVER PLUTON - INTERPRETATION

Two samples were studied from this pluton. In both cases, samples of potassic feldspar (KF) and quartz-plagioclase feldspar (QP) were analyzed in addition to the whole-rock (WR) samples. The data yield a reasonably good isochron with an indicated primary age of 504 ± 27 Ma with R_o = 0.7041 ± 0.0033.

The age obtained is appreciably older than ages obtained for other plutons in the Cobequids (Cape Chignecto, Hart Lake and Byers Lake) which were Lower Carboniferous. However, the age obtained for the Salmon River pluton is similar to ages obtained in some plutons in the Antigonish Highlands, e.g. the Georgeville pluton (508 Ma) and the Ohio River pluton (533 Ma). It is also similar to Rb/Sr and K/Ar mineral ages reported for Jeffers Brook in the western Cobequids.

SALMON RIVER PLUTON - ANALYTICAL RESULTS

SAMPLE NUMBER	Rb (ppm)	Sr (ppm)	87Rb/86Sr	87Sr/86Sr
E11-4113 WR	174	83.0	6.10	0.7470
E11-4113 KF	422	85.0	14.5	0.8100
E11-4113 QP	59.2	73.7	2.33	0.7230
E11-4114 WR	148	85.9	5.00	0.7369
E11-4114 KF	323	86.8	10.8	0.7799
E11-4114 QP	34.1	82.9	1.19	0.7137

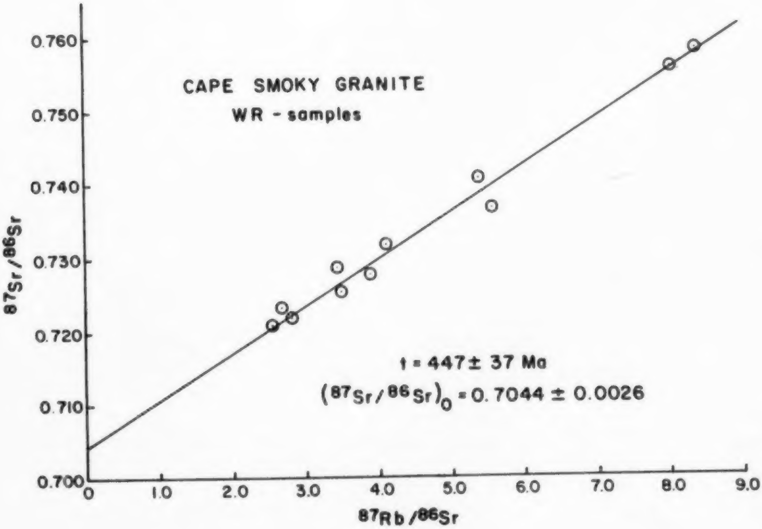


ANALYTICAL DATA - CAPE SMOKY PLUTON - CAPE BRETON ISLAND

SAMPLE NUMBER	Rb (ppm)	Sr (ppm)	87Rb/86Sr	87Sr/86Sr
CT-12 WR[1]	148	51.2	8.39	0.7583
K9B-1571 WR	144	52.0	8.05	0.7558
K9B-1564 WR	143	74.3	5.58	0.7367
K9B-1580 WR	116	62.4	5.40	0.7407
CT-11 WR	115	81.4	4.12	0.7316
K9B-1764 WR	132	97.8	3.91	0.7279
CT-13 WR	109	89.8	3.51	0.7254
CT-15 WR	152	128	3.44	0.7288
CT-14 WR	92.6	95.8	2.80	0.7217
K9B-1512 WR	109	119	2.67	0.7233
K9B-1754 WR	120	137	2.54	0.7208

t = 447 ± 37 Ma with R_o = 0.7044 ± 0.0026

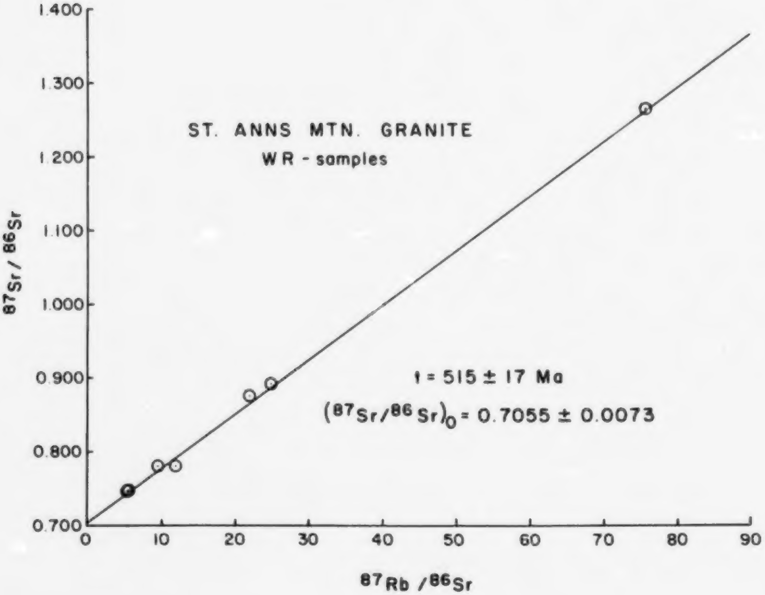
[1] - Samples labelled CT collected several years ago along Cabot Trail on Cape Smoky by R. F. Cormier.



ANALYTICAL DATA - SAINT ANNS MOUNTAIN PLUTON - CAPE BRETON ISLAND

SAMPLE NO.	Rb (ppm)	Sr (ppm)	87Rb/86Sr	87Sr/86Sr
K7A-1504 WR	258	10.4	76.0	1.2609
K7A-1500 WR	202	23.7	24.9	0.8923
K7A-1507 WR	191	25.5	22.0	0.8757
K7A-1555 WR	127	31.1	11.9	0.7830
K7A-1570 WR	166	50.5	9.60	0.7812
K7A-1546 WR	127	62.3	5.91	0.7480
K7A-1796 WR	144	73.5	5.70	0.7463

t = 515 ± 17 Ma $\qquad$ R_o = 0.7055 ± 0.0073

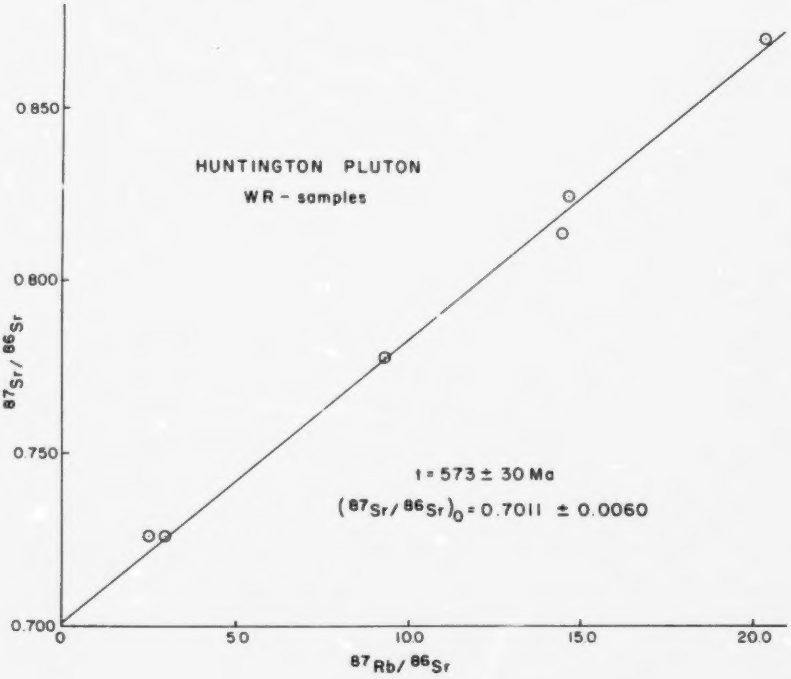


ANALYTICAL DATA - HUNTINGTON PLUTON - CAPE BRETON ISLAND

SAMPLE NUMBER	Rb (ppm)	Sr (ppm)	87Rb/86Sr	87Sr/86Sr
11F16C-1529 WR	318	45.9	20.4	0.8701
11F16C-1618 WR	213	42.5	14.7	0.8247
11F16C-1550 WR	220	44.3	14.5	0.8137
11F16C-1558 WR	196	61.0	9.33	0.7776
11F16C-1540 WR	184	181	2.95	0.7258
11F16C-1578 WR	163	191	2.48	0.7258

t = 573 ± 30 Ma

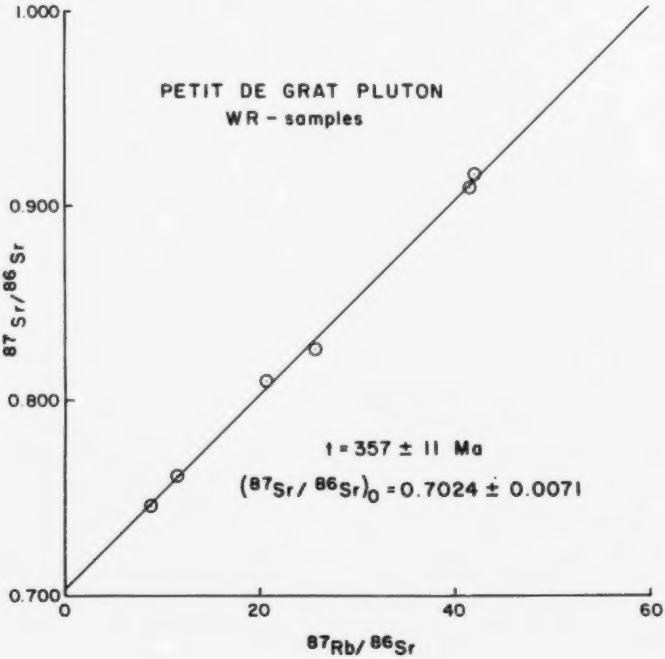
R_o = 0.7011 ± 0.0060



ANALYTICAL DATA - PETIT DE GRAT PLUTON - CAPE BRETON ISLAND

SAMPLE NUMBER	Rb (ppm)	Sr (ppm)	87Rb/86Sr	87Sr/86Sr
11F7-1014 WR	279	19.5	42.1	0.9144
11F7-1009 WR-a	319	22.4	42.1	0.9112
11F7-1009 WR-b	310	22.2	41.2	0.9068
Avg.	315	22.3	41.7	0.9090
11F7-1012 WR	258	29.3	25.8	0.8260
11F7-1013 WR	279	39.4	20.7	0.8095
11F7-1000 WR	168	42.9	11.4	0.7610
11F7-1004 WR	153	50.9	8.75	0.7458

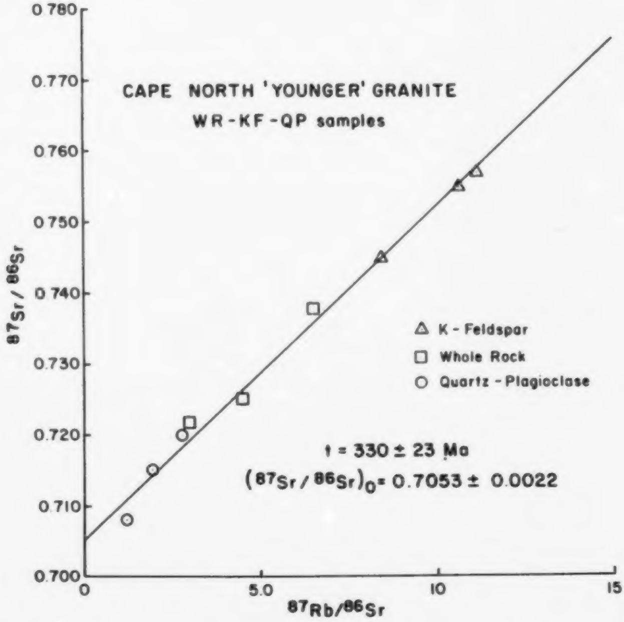
t = 357 ± 11 Ma R_o = 0.7024 ± 0.0071



ANALYTICAL DATA - CAPE NORTH 'YOUNGER' GRANITE - CAPE BRETON ISLAND

SAMPLE NUMBER	Rb (ppm)	Sr (ppm)	87Rb/86Sr	87Sr/86Sr
16K-1087 KF	618	162	11.1	0.7568
16K-1087 WR	272	122	6.45	0.7372
16K-1087 QP	106	108	2.84	0.7199
16K-1160 KF	808	221	10.6	0.7548
16K-1160 WR	248	162	4.43	0.7248
16K-1160 QP	93.8	138	1.96	0.7150
NO1-1158 KF	681	236	8.39	0.7448
NO1-1158 WR	210	206	2.96	0.7215
NO1-1158 QP - A	72.1	171	1.22	0.7077
NO1-1158 QP - B	84.9	172	1.43	0.7090

t = 330 ± 23 Ma $\qquad$ R_o = 0.7053 ± 0.0022



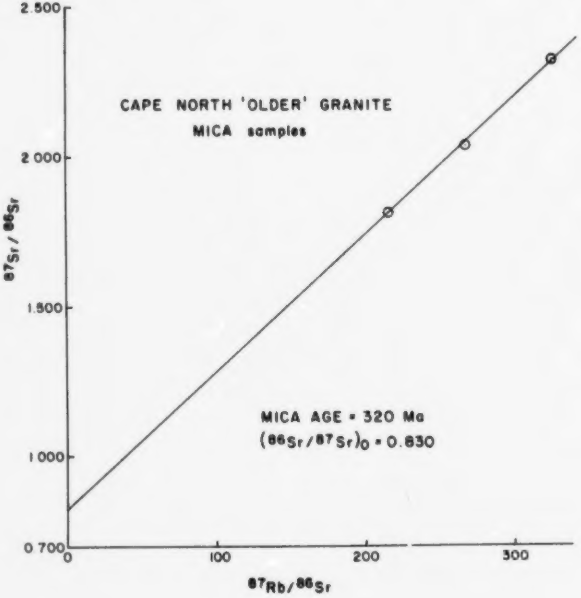
CAPE NORTH 'OLDER' GRANITE - INTERPRETATION

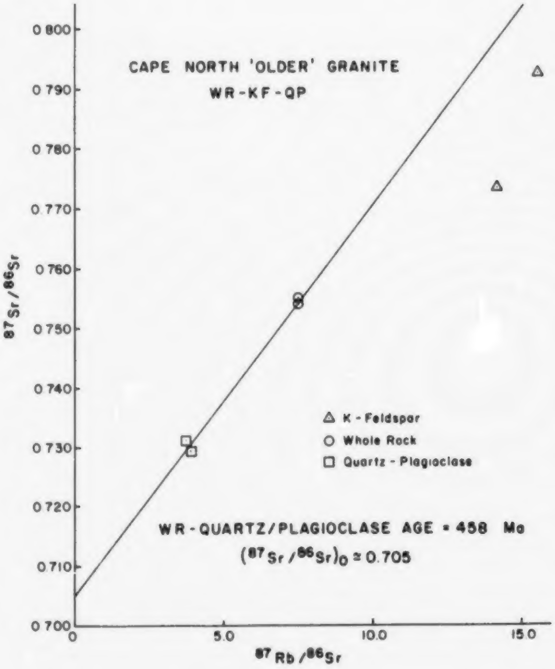
Whole rock and mineral separates from two samples of this granite were analyzed. The data do not define a simple isochron. Ages calculated for the micas using an assumed R_o = 0.715 agree quite well; 350 Ma for biotite from #1082 and 347 and 361 Ma for biotite and muscovite respectively from #1184. These values are typically Acadian, but may represent overprinting. If the data for the micas are plotted on an isochron diagram, they are closely colinear and yield an age of 320 Ma with a very high R_o = 0.830. This could be interpreted as overprint at about 320 Ma and is similar to the age obtained for the nearby Cape North 'younger' granite, 330 Ma.

The potassic feldspar, quartz-plagioclase feldspar and whole rock data do not define a single isochron and appear to have undergone partial overprinting. In both samples, the WR and QP fractions plot very close to one another; a 'two-point' isochron drawn through them gives an 'age' of about 458 Ma with R_o = about 0.705, values close to those found for the Cape Smoky granite (447 Ma and 0.7044). We could interpret this to be close to the intrusion age of the 'older' granite. The KF samples from both specimens plot well below the 'two-point' isochron and appear to have undergone partial resetting, perhaps at the time the 'younger' granite appears to have been intruded, about 330 Ma ago.

ANALYTICAL DATA - CAPE NORTH 'OLDER' GRANITE - CAPE BRETON ISLAND

SAMPLE NUMBER		Rb (ppm)	Sr (ppm)	87Rb/86Sr	87Sr/86Sr
K16-1082	Bi	1078	13.2	266	2.0425
K16-1082	KF	628	117	15.6	0.7924
K16-1082	WR	167	64.3	7.55	0.7548
K16-1082	QP	70.9	53.1	3.87	0.7294
K16-1184	Bi	933	9.82	325	2.3265
K16-1184	Mu	696	10.3	215	1.8224
K16-1184	KF	493	101	14.2	0.7734
K16-1184	WR	125	48.6	7.46	0.7537
K16-1184	QP	45.3	34.9	3.76	0.7309


CAPE NORTH 'OLDER' GRANITE
MICA samples
MICA AGE = 320 Ma
$(^{86}Sr/^{87}Sr)_0 = 0.830$
$^{87}Sr/^{86}Sr$
2.500
2.000
1.500
1.000
0.700
0
100
200
300
$^{87}Rb/^{86}Sr$


CAPE NORTH 'OLDER' GRANITE
WR-KF-QP
△ K - Feldspar
○ Whole Rock
□ Quartz - Plagioclase
WR - QUARTZ/PLAGIOCLASE AGE = 458 Ma
$(^{87}Sr/^{86}Sr)_0 = 0.705$
$^{87}Sr/^{86}Sr$
0.800
0.790
0.780
0.770
0.760
0.750
0.740
0.730
0.720
0.710
0.700
0
5.0
10.0
15.0
$^{87}Rb/^{86}Sr$

NEW OPEN ASSESSMENT REPORTS FOR 1979 (NOW ON MICROFILM)

11D/13D 54-H-80(01)	Uranium	Grand Lake, Halifax County	Seaton Uranium Prospect, Seaton, Oct. 1979
11D/15C 53-H-49(06)	Tungsten	Moose River, Halifax County	Rept. on the Stillwater Scheelite Property, Damian Nance, Aug. 1977
11E/02A 21-H-01(03)	Gold	Beaverdam, Halifax County	DDH Logs, Ron Thornton, Feb. 1977
11E/03A 07-H-20(01)	Base Metals	Elmsvale, Halifax County	Nova Minerals-1976 Follow Up Program, Imp. Oil Ltd., Dec. 1976
11E/03B 07-D-21(01)	Base Metals	Gays River, Colchester County	Prelim. Seismic Map, Chevron, Dec. 1977
11E/03B 07-D-59(01)	Base Metals	St. Andrews, Colchester County	Nova Minerals-1976 Follow Up Program, Imp. Oil Ltd., Dec. 1976
11E/03C 07-D-46(01)	Base Metals	Green Creek, Colchester County	Nova Minerals-1976 Follow Up Program, Imp. Oil Ltd., Dec. 1976
11E/03D 07-D-34(01)	Base Metals	Middle Stewiacke, Colchester County	Nova Minerals-1976 Follow Up Program, Imp. Oil Ltd., Dec. 1976
11E/03D 07-D-34(02)	Base Metals	Middle Stewiacke, Colchester County	Rept. on Geochem. Svys., Areas E and F, Imperial Oil Ltd., Sept. 1977
11E/03D 07-D-34(03)	Base Metals	Middle Stewiacke, Colchester County	Rept. on Geochem. Svys., Area D, Imp. Oil. Ltd., Sept. 1977
11E/03D 07-D-34(04)	Base Metals	Middle Stewiacke, Colchester County	Rept. on Geochem. Svys., Areas E and F, Imp. Oil Ltd., Sept. 1977
11E/03D 07-D-34(05)	Base Metals	Middle Stewiacke, Colchester County	Rept. on Geochem. Svys., Area D, Imp. Oil Ltd., Sept. 1977
11E/03D 07-D-38(01)	Base Metals	Otter Brook, Colchester County	Nova Minerals-1976 Follow Up Program, Imp. Oil Ltd., Dec. 1976
11E/04A 07-I-32(01)	Base Metals	Indian Road, Hants County	Nova Minerals-1976 Follow Up Program, Imp. Oil Ltd., Dec. 1976

11E/04B 03-I-55(14)	Antimony	West Gore, Hants County	West Gore Antimony Project, Hants Co. Mng. Ltd., April 1977
11E/05B 07-I-49(01)	Base Metals	Tennycape, Hants County	Rept. of Exploration Work, Preuvier, Dec. 1978
11E/05D 07-D-28(01)	Base Metals	Probert, Colchester County	Statement of Expenditures and Expl. Rept., Westfield Minerals Ltd., July 1977
11E/05D 07-D-28(02)	Base Metals	Probert, Colchester County	Rept. on Induced Polarization Survey, Westfield Minerals Ltd., Oct. 1977
11E/05D 07-D-33(01)	Base Metals	Londonderry, Colchester County	Picket Line Grid Map, Falconbridge, Dec. 1976
11E/05D 07-D-39(01)	Base Metals	Portapique, Colchester County	Statement of Expenditures and Expl. Rept., Westfield Minerals Ltd., July 1977
11E/06A 07-D-07(03)	Base Metals	Brookfield, Colchester County	Rept. on Exploration in the Stewiacke Valley, Imp. Oil Ltd., Nov. 1976
11E/06A 07-D-41(01)	Base Metals	Smithfield, Colchester County	Rept. on Exploration in the Stewiacke Valley, Imp. Oil Ltd., Nov. 1976
11E/06B 02-D-26(01)	Anhydrite	Hilden, Colchester County	DDH Logs, U. S. Borax, Jan. 1977
11E/06B 07-D-50(01)	Base Metals	Beaverbank, Colchester County	Nova Minerals-1976 Follow Up Program, Imp. Oil Ltd., Dec. 1976
11E/06B 07-D-58(02)	Base Metals	Pleasant Valley, Colchester County	Nova Minerals-1976 Follow Up Program, Imp. Oil Ltd., Dec. 1976
11E/06C 54-D-55(02)	Uranium	Masstown, Colchester County	Annapolis Valley Progress Rept., Getty Mines Ltd., Nov. 1976
11E/06D 07-D-60(01)	Base Metals	Riversdale, Colchester County	Nova Minerals-1976 Follow Up Program, Imp. Oil Ltd., Dec. 1976
11E/07B 07-D-18(01)	Base Metals	Eastville, Colchester County	Rept. on Mining Claims, Project 224, St. Joseph Expl., May 1977

11E/07B 07-D-18(02)	Base Metals	Eastville, Colchester County	Rept. on Geochem. Svy., Area A, Imperial Oil Ltd., Sept. 1977
11E/07B 07-D-18(03)	Base Metals	Eastville, Colchester County	Rept. on Geochem. Svy., Area A, Imperial Oil Ltd., Sept. 1977
11E/07B 07-D-23(01)	Base Metals	Pembroke, Colchester County	Rept. on Expl. in the Stewiacke Valley, Imp. Oil Ltd., Nov. 1976
11E/07B 07-D-23(02)	Base Metals	Pembroke (Glenbervie), Colchester County	Rept. on Geochem. Svy., Area B, Imperial Oil Ltd., Sept. 1977
11E/07B 07-D-23(03)	Base Metals	Pembroke (Glenbervie), Colchester County	Rept. on Geochem. Svy., Area B, Imperial Oil Ltd., Sept. 1977
11E/09D 07-M-36(01)	Base Metals	Knoydart, Pictou County	Rept. on Geol. and Geochem. Svys., Chevron, Dec. 1977
11E/10A 07-M-15(01)	Base Metals	MacLellans Brook, Pictou County	Rept. on Prospect, Imperial Oil Ltd., Nov. 1976
11E/11C 54-D-45(02)	Uranium	Tatamagouche, Colchester County	Report of Work, Noranda, July 1977
11E/11C 54-D-45(03)	Uranium	Tatamagouche, Colchester County	Rept. of Work and Maps to Sept. 30, 1977, Noranda, Nov. 1977
11E/11C 54-D-45(04)	Uranium	Tatamagouche, Colchester County	Rept. of Work to Sept. 30, 1977, Noranda, Dec. 1977
11E/12C 54-E-23(01)	Uranium	Oxford, Cumberland County	Cobequid I. Rept. of Expl. Program, 1976, Gulf Minerals, Feb. 1977
11E/12D 54-E-60(01)	Uranium	Henderson Brook, Cumberland County	Soil and Radon Geochem. Svys., Aquitaine, Oct. 1977
11E/13A,B,C,D 54-E-33(01)	Uranium	Pugwash, Cumberland County	Summer Report, Lacana, Oct. 1976

11E/13A,B,C,D 54-E-33(02)	Uranium	Pugwash, Cumberland County	Rept. on Diamond Drilling, Norcen, Feb. 1977
11E/14A 54-M-37(01)	Uranium	River John, Pictou County	Rept. of Work, Noranda, July 1977
11E/16A 27-B-13(01)	Lead	Georgeville, Antigonish County	Rept. of Assessment Work, Gold Brook Develop. Ltd., Oct. 1976
11F/05B 21-G-13(12)	Gold	Forest Hill, Guysborough County	Basal Till Sampling and Geophys., Int. Geochem. Assoc., July 1977
11F/09C 07-0-25(02)	Base Metals	Stirling, Richmond County	1976 Linecutting Rept., Cominco, Feb. 1976
11F/09C 07-0-25(03)	Base Metals	Stirling, Richmond County	1976 Linecutting Rept., Cominco, Jan. 1977
11F/09C 07-0-25(04)	Base Metals	Stirling, Richmond County	Assessment Rept. on Geol. and Geochem. Expl. Program, Metallgesellschaft, Jan. 1977
11F/09C 07-0-25(05)	Base Metals	Stirling, Richmond County	Geol., Geochem. and Geophys. Rept., 1977, Cominco, Nov. 1977
11F/09C 07-0-25(06)	Base Metals	Stirling, Richmond County	Geol. and Geochem. Rept., 1977, Cominco, Nov. 1977
11F/09C 07-0-25(07)	Base Metals	Stirling, Richmond County	Geology Rept., 1977, Cominco, Nov. 1977
11F/09C 07-0-25(08)	Base Metals	Stirling, Richmond County	Geology Rept., 1977, Cominco, Nov. 1977
11F/10C 42-0-21(01)	Salt	St. Peters, Richmond County	St. Peters Hole No. 1, DDH Log and Gravity Maps and Kingsville DDH Log, Domtar, 1966
11F/11B,A,C,D 42-J-50(01)	Salt	Port Hawkesbury, Inverness County	Gravity Interpretation, Murphy Oil, 1971
11F/11B 42-0-30(01)	Salt	Port Richmond, Richmond County	Rept. On Ownership of Lands at Port Richmond, Dow Chem. of. Can. Ltd., Nov. 1966
11F/11B 42-0-30(02)	Salt	Port Richmond, Richmond County	Hole No. 1-Rept. of Work Performed-Geol., Geophys., DDH, Dow Chem. of Can. Ltd., Apr. 1967

11F/11B 42-0-30(03)	Salt	Port Richmond, Richmond County	Holes No. 2 and 3 - Geol. Repts., Analy. Data, DDH Logs, Gravity and Hydrosond Svys., Dow Chem., 1968
11F/11B 42-0-30(04)	Salt	Port Richmond, Richmond County	Gravity, Analy. Data, and DDH Logs, Dow Chem. of Can. Ltd., 1969
11F/11B 42-0-30(05)	Salt	Port Richmond, Richmond County	(Little River) DDH Logs DCPR4-10, Dow Chem. of Can. Ltd., 1970
11F/11B 42-0-30(06)	Salt	Port Richmond, Richmond County	Port Malcolm No. 1-1972 Program, Dow Chem. of Can. Ltd., 1972
11F/11B 42-0-30(07)	Salt	Port Richmond, Richmond County	Gravity Interpretation, Dow Chem. of Can. Ltd., 1972
11F/11C,B 42-J-68(01)	Salt	McIntyre Lake, Point Tupper, Port Hawkesbury, Inverness County	NCO Canso Strat. No. 1- U.T.M. Grid PF633950 (Easting) 5058220 (Northing), Murphy Oil Co. Ltd., Aug. 1972
11F/11C,B 42-J-68(02)	Salt	McIntyre Lake, Point Tupper, Port Hawkesbury, Inverness County	NCO Canso Strat. No. 2-11 U.T.M. Grid PF633950 (Easting) 5058220 (Northing), Murphy Oil Co. Ltd., Aug. 1972
11F/12B,C 07-B-35(01)	Base Metals	Lower South River, Antigonish County	Geol. Rept., U.S. Borax, July 1976
11F/12B,C 07-B-35(02)	Base Metals	Lower South River, Antigonish County	Annual Rept., U.S. Borax, July 1977
11F/12D, 11C 42-B-31(01)	Salt	Havre Boucher, Antigonish County	Gravity Svy. of Canso Area, Murphy Oil Co. Ltd., 1970
11F/14C 25-J-21(05)	Iron	Glencoe, Inverness County	Planetable Svy. and Compilation, W. S. Shaw, Sept. 1976
11F/14D 40-J-59(01)	Potash	Whycocomagh, Inverness County	Rept. of Work, Sp. Lic. 1-77, and Gravity Svy., Noranda, Dec. 1977
11F/14D 42-J-59(01)	Salt	Whycocomagh, Inverness County	Gravity Map, Domtar, 1967

11F/15A 07-0-61(01)	Base Metals	Loch Lomond, Richmond County	Computer Reduction of DDH Data, Vols. I, II, Esso Minerals, Sept. 1978
11F/15A 07-0-61(02)	Base Metals	Loch Lomond, Richmond County	DDH Logs and Maps, Terra Nova Prospect, Amax, Dec. 1977
11F/15B 07-J-71(01)	Base Metals	Bras D'Or, Inverness County	Rept. on Geol., Geochem. and Geophys. Svys., Chevron, Nov. 1977
11F/15C 07-Q-09(01)	Base Metals	Jubilee, Victoria County	DDH Logs, Amax, Feb. 1977
11F/15C 07-Q-38(01)	Base Metals	Iona Rear, Victoria County	Rept. on I.P. Svy., Texam, Feb. 1977
11F/16B 07-0-08(01)	Base Metals	Hay Lake(Stirling), Richmond County	Linecutting Rept. on Stirling Property, Cominco, Dec. 1976
11F/16D 07-C-31(01)	Base Metals	Deep Cove, Cape Breton County	Rept. on Mining Claims, Project 223, St. Joseph Expl., April 1977
11F/16D 07-C-40(01)	Base Metals	French Road, Cape Breton County	Rept. on Mining Claims, Project 159, St. Joseph Expl., May 1976
11F/16D 07-C-40(02)	Base Metals	French Road, Cape Breton County	Rept. on Field Work, Project 159, St. Joseph Exploration, Feb. 1977
11F/16D 07-C-40(03)	Base Metals	French Road, Cape Breton County	Rept. on Mining Claims, McDonald Lake Property, Project 158, St. Joseph Expl., Dec. 1977
11F/16D 07-C-40(04)	Base Metals	French Road, Cape Breton County	Rept. on Diamond Drilling, Project 159, St. Joseph Expl., July 1977
11F/16D 07-C-40(05)	Base Metals	French Road, Cape Breton County	Rept. on Diamond Drilling, Project 158, McDonald Lake Property, St. Joseph Expl., March 1977
11K/01B,C 07-C-15(01)	Base Metals	Boisdale Hills, Cape Breton County	Geol. and Mineralization of the Boisdale Hills Prop., Aquitaine Co. of Can. Ltd., July 1976

11K/01B 07-C-27(01)	Base Metals	Coxheath, Cape Breton County	Geophys. Svys., Coxheath Property Holdings, June 1977
11K/02C 54-Q-41(01)	Uranium	Harris Brook, Victoria County	Geol., Geochem. and Geophys. Svys., Urangesellschaft, Oct. 1977
11K/03B 07-J-22(01)	Base Metals	Glendyer, Inverness County	Geophys. Svy., Int. Geochem. Assoc., June 1977
11K/03B 10-J-35(08)	Coal	Mabou, Inverness County	Rept. on Marine Seismic Profiling Svy. over a coal prospect at Mabou, Biron Bay Gold Mines, June 1977
11K/03C 07-J-72(01)	Base Metals	More Brook, Inverness County	Rept. on 1977 Exploration, Coxheath Property Holdings, Sept. 1977
11K/08B 16-Q-40(01)	Dolomite	Kelly Cove, Victoria County	Rept. of Investigation, W. Shaw, Sept. 1977
11K/10B 07-J-09(44)	Base Metals	Cheticamp, Inverness County	Preliminary Rept., Yeoman Syndicate, Aug. 1976
11K/10B 07-J-09(45)	Base Metals	Cheticamp, Inverness County	Geol. and Geochem. Rept., Yeoman Syndicate, Jan. 1977
11K/10B 07-J-69(01)	Base Metals	Fisset Brook, Inverness County	Rept. of Work, Utah Mines, Feb. 1977
11K/10B 07-J-69(02)	Base Metals	Fisset Brook, Inverness County	Rept. of Diamond Drilling, Utah Mines, Feb. 1977
11K/10B 07-J-70(01)	Base Metals	Margaree Valley, Inverness County	Rept. of Work, Utah Mines, Feb. 1977
11K/10B 35-J-55(01)	Molybdenum	Rocky Brook, Inverness County	Rept. of Assessment Work, Gold Brook Developments, Nov. 1976
11K/10B 35-J-55(02)	Molybdenum	Rocky Brook, Inverness County	Rept. of Assessment Work, Gold Brook Developments, June 1977
11K/10B,07C 35-J-55(03)	Molybdenum	Rocky Brook, Inverness County	Rept. of Assessment Work, Gold Brook Developments, July 1977

11K/10B,07C 35-J-55(04)	Molybdenum	Rocky Brook, Inverness County	Rept. of Assessment Work, Gold Brook Developments, Aug. 1977
200/16A 07-R-24(01)	Base Metals	Yarmouth, Yarmouth County	Yarmouth Project, Millmor Syndicate, Aug. 1976
20P/13C 07-R-10(01)	Base Metals	Tusket, Yarmouth County	Work Rept. on Joint Venture, Kerr Addison Mines, Oct. 1977
21A/07B 21-N-11(17)	Gold	Molega, Queens County	Work Rept. by Fred Rhodenizer, Sept. 1976
21A/08B 53-L-13(09)	Tungsten/Gold	Indian Path, Lunenburg County	Progress Rept. on Expl. Work, Ron Thornton, Nov. 1977
21A/08B 53-L-13(10)	Tungsten/Gold	Indian Path, Lunenburg County	Indian Path Gold/Tungsten Prospect, Ron Thornton, Nov. 1977
21A/12B 54-F-02(01)	Uranium	Rossway, Digby County	Annapolis Valley Progress Rept., Getty Mns. Ltd., Nov. 1976
21A/14B 54-A-02(01)	Uranium	Bridgetown, Annapolis County	Annapolis Valley Progress Rept., Getty Mns. Ltd., Nov. 1976
21A/14B 54-A-02(02)	Uranium	Bridgetown, Annapolis County	Exploration Rept., Getty Mns. Ltd., Feb. 1977
21A/14B 54-A-07(01)	Uranium	Belleisle, Annapolis County	Annapolis Valley Progress Rept., Getty Mns. Ltd., Nov. 1976
21A/14B 54-A-07(02)	Uranium	Belleisle (East), Annapolis County	Exploration Rept., Getty Mns. Ltd., Feb. 1977
21A/14B 54-A-07(03)	Uranium	Bellisle (West), Annapolis County	Exploration Rept., Getty Mns. Ltd., Feb. 1977
21A/14D 54-A-09(01)	Uranium	Middleton, Annapolis County	Annapolis Valley Progress Rept., Getty Mns. Ltd., Nov. 1976
21A/14D 54-A-09(02)	Uranium	Middleton, Annapolis County	Exploration Rept., Getty Mns. Ltd., Feb. 1977
21H/01B 31-K-11(01)	Manganese	Kentville, Kings County	Sum. Rept., Groups I & II, Manganese Project, Ecol. Resources Conslt., Oct. 1977

21H/01B 54-K-11(01)	Uranium	Kentville, Kings County	Annapolis Valley Progress Rept., Getty Mns. Ltd., Nov. 1976
21H/01B,C 54-K-11(02)	Uranium	Kentville, Kings County	Exploration Rept., Getty Mns. Ltd., Feb. 1977
21H/01C 54-K-04(01)	Uranium	Blomidon, Kings County	Annapolis Valley Progress Rept., Getty Mns. Ltd., Nov. 1976
21H/01C 54-K-04(02)	Uranium	Blomidon, Kings County	Exploration Rept., Getty Mns. Ltd., Feb. 1977
21H/01C 54-K-24(01)	Uranium	Sheffield, Kings County	Exploration Rept., Getty Mns. Ltd., Feb. 1977
21H/01D 07-I-05(01)	Base Metals	Cheverie, Hants County	Nova Minerals-1976 Follow Up Program, Imp. Oil Ltd., Dec. 1976
21H/02A 54-K-05(01)	Uranium	Berwick, Kings County	Annapolis Valley Progress Rept., Getty Mns. Ltd., Nov. 1976
21H/02A,B,D 54-K-05(02)	Uranium	Berwick, Kings County	Exploration Rept., Getty Mns. Ltd., Feb. 1977
21H/02B 54-K-01(01)	Uranium	Auburn, Kings County	Annapolis Valley Progress Rept., Getty Mns. Ltd., Nov. 1976
21H/02B 54-K-01(02)	Uraniun	Auburn, Kings County	Exploration Rept., Getty Mns. Ltd., Feb. 1977
21H/02B 54-K-20(01)	Uranium	North Kingston, Kings County	Sum. Drilling Rept., Getty Mines Ltd., April 1978
21H/08C 07-E-25(01)	Base Metals	Parrsboro, Cumberland County	Rept. for Year End, Westfield Minerals Ltd., May 1977
21H/08C 07-E-25(02)	Base Metals	Parrsboro, Cumberland County	Rept. on I. P. Svy., Westfield Minerals Ltd., Oct. 1977
21H/08D 07-D-19(01)	Base Metals	Five Islands, Colchester County	1. Assessment Rept. and 16 Maps - Geochem. and Geophys., Falconbridge, Feb. 1977 2. Assessment Rept. and Geol. Map, Falconbridge, Sept. 1977

21H/08D 07-D-19(02)	Base Metals	Five Islands, Colchester County	1. Assessment Rept. and Geochem. and Geol. Map, Falconbridge, Mar. 1977 2. Assessment Rept., Falconbridge, Sept. 1977
21H/08D 07-D-19(03)	Base Metals	Five Islands, Colchester County	Assessment Rept. and Geochem. and Geol. Map, Falconbridge, April 1977
21H/08D 07-D-19(04)	Base Metals	Five Islands, Colchester County	1. Assessment Rept. - Geochem. Svy., Geophys. Svy and Geol. Svy., Falconbridge, June 1977 2. Assessment Rept., Falconbridge, Sept. 1977
21H/08D 54-D-19(01)	Uranium	Five Islands, Colchester County	Cobequid II. Rept. of Expl. Program 1976, Gulf Minerals, Feb. 1977

AVAILABLE PUBLICATIONS

NOVA SCOTIA DEPARTMENT OF MINES AND ENERGY

Paper 76-1	Structural Model for the Saddle Reef and Associated Gold Veins in the Meguma Group, Nova Scotia, by J. D. Keppie	$3.00
Paper 76-2	Geological Data Collection in the Nova Scotia Department of Mines, by J. D. Keppie and A. K. Chatterjee	$0.50
Paper 76-3	Interpretation of P.P.I. Radar Imagery of Nova Scotia, by J. D. Keppie	$1.25
Paper 76-4	Geology, Geochemistry & Mineral Occurrences of the Northeast Margaree River Drainage Basin in parts of Inverness & Victoria Cos., Cape Breton, Nova Scotia, by B. E. MacNabb, J. H. Fowler & T. G. N. Covert. (30 p., 12 maps)	$15.00
Paper 76-5	Guide to the Invertebrate Fauna of the Windsor Group in Atlantic Canada, by R. G. Moore and R. J. Ryan, 1976	$2.25
Paper 77-1	Tectonics of Southern Nova Scotia, by J. D. Keppie	$1.50
Paper 77-3	Plate Tectonic Interpretation of Paleozoic World Maps (with Emphasis on Circum-Atlantic Orogens and Southern Nova Scotia), by J. D. Keppie	$8.50
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Report 76-1	Drilling Logs of Government Core Drills - 1974	$1.00
Report 76-2	Mineral Resources Division, Report of Activities - 1975	$3.00
Report 76-3	Drilling Logs of Government Core Drills - 1975	$1.00
Report 77-1	Mineral Resources Division, Report of Activities - 1976	$10.00
Report 77-2	Index to Mineral Assessment Reports, by Diane J. Gregory plus supplement	$10.00
Report 77-3	Drilling Logs of Government Core Drills - 1976	$1.00
Report 78-1	Mineral Resources Division, Report of Activities - 1977	$4.00
Report 78-2	Drilling Logs of Government Core Drills, 1977	$2.00
Report 78-3	Index to Open File Reports, by Diane J. Gregory	$1.25
Report 78-4	A Compilation of Isotopic Age Data for the Canadian Appalachians, by J. D. Keppie & P. K. Smith	$7.00
Report 79-1	Mineral Resources Division, Report of Activities-1978	$6.00

Memoir 4	The Older Paleozoic of Pictou County, Nova Scotia, by R. H. Maehl, 1961	$3.00
Memoir 5	Pleistocene Geology of the Annapolis Valley, Nova Scotia, by C. R. Hickox, Jr., 1962	$2.00

Bulletin 1	Port Hawkesbury Project - Geological, Geochemical and Groundwater Investigations of Southwestern Inverness and Richmond Counties, Nova Scotia, by R. S. Shea and J. D. Wallace, 1962	$2.00
Bulletin 2	Limestone and Dolomites of Nova Scotia - Cape Breton Island, Part I, by F. S. Shea and D. A. Murray, 1969	$4.00
Bulletin 2	Limestones and Dolomites of Nova Scotia - Guysborough, Antigonish, Pictou and Cumberland Counties, Part II, by D. A. Murray	$6.50
Bulletin 3	Assessment of Peat Moss Occurrences in Guysborough, Antigonish, Pictou, Colchester and Cumberland Counties, Nova Scotia (Peat Moss Project, A.R.D.A., 1964-1966) by D. R. Sutherland and F. S. Shea, 1976 (Reprinted)	$7.00
Bulletin 4	Barite, Celestite and Fluorite in Nova Scotia, by G. W. Felderhof, 1978. (463 p., 200 figs., 12 tables)	$13.00

Information Series:

No. 1	Geology, Minerals and Mining in Nova Scotia, by J. M. Richardson and D. J. Gregory, 1976.	Free
No. 2	A History of Coal Mining in Nova Scotia, compiled by D. J. Gregory, 1978	Free

Economic Geology Series: (discontinued)

74-1	Geology and Trace Element Studies of Nova Scotia Manganese Occurrences, by D. G. Bishop, 1974	$7.50
75-1	Iron Deposits of Nova Scotia, by J. D. Wright	$6.00

Report of Activities 1974, Nova Scotia Department of Mines	$1.00
Core Drilling in Nova Scotia with Government Drills, 1871-1966 (INDEX)	$2.00
Core Drilling in Nova Scotia with Government Drills, 1967-1971 (INDEX)	$1.00
Drilling Logs of Government Core Drills, 1958-1973. Complete set: (each $1.00) (Logs are in Mines Reports prior to 1958) (Logs are numbered Reports after 1973)	$16.00
Possibilities for Occurrence of Petroleum Reservoirs in Nova Scotia, by W. A. Bell, 1958	$1.00
Metallic Mineral Occurrences Recorded in the Province of Nova Scotia, Nova Scotia Department of Mines, 1966	$4.00
Handbook for Companies Planning Offshore Drilling, Nova Scotia Department of Mines, 1969	$0.50
Clay and Sand Deposit at Elmsdale, Halifax County, Nova Scotia, by J. H. Fowler, 1972	$2.50
Geology of the Middle River Baddeck Forks Map Areas, Victoria County, Nova Scotia, by B. E. Jones and T. G. N. Covert, 1972	$5.00
Petroleum Exploration in Nova Scotia, by W. Potter and T. Dexter, 1974	$1.00
Bibliography of the Geology of Nova Scotia, by D. J. Gregory, 1976	$6.25
Coal Mines Regulation Act	$2.50
Petroleum and Natural Gas Act and Regulations Thereunder Act	
Respecting Exploration for the Underground Storage of Gas Resume of Mineral Resources Act	
An Act Respecting Mineral Resources and Regulations (Regulations - $1.00, Act - $1.50)	$2.50
Metalliferous Mines and Quarries Regulation Act	
Gypsum Mining Income Tax Act	

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Preliminary Map 78-1 Geology Map of the Cobequid Highlands, by Howard V. Donohoe Jr. & Peter I. Wallace	$3.50
Geological Map of Nova Scotia. Scale 1" = 8 miles	$1.00
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Onshore Petroleum Map	$1.00
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N.B. This is not a complete listing of Departmental Publications. Older publications by the Department of Mines are now out of print; however, it is possible that several may be reprinted, depending of their demand. The above publications can be obtained from the Library, Nova Scotia Department of Mines and Energy, P.O. Box 1087, Halifax, Nova Scotia, B3J 2X1. Please make cheques payable to the Minister of Finance.